Exchange Rate Volatility, Employment and Macroeconomic Dynamics in South Africa

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Trust Reason Mpofu

Supervisors:

Professor Haroon Bhorat

Dr. Amos Peters

Abstract

This thesis focuses on the effects and causes of exchange rate volatility in South Africa. These issues are analysed in three stand-alone but related papers. The first paper (Chapter 2) investigates the impact of real exchange rate volatility on employment growth in the manufacturing sector. The study contributes to the literature on the employment effects of exchange rate volatility in emerging markets given limited studies. This is done by using the Autoregressive Distributed Lag (ARDL) cointegration approach which is able to estimate an error correction form of the model for the variables under investigation. This enables one to analyse the relationship between exchange rate volatility and employment growth. The advantage of this approach is that it performs better in small samples and works well even when the underlying variables are integrated of different orders. Employing quarterly time series data for the period 1995 — 2010, the analysis shows that real exchange rate volatility has a significant contractionary effect on manufacturing employment growth. The study also provides evidence that exchange rate level, output, wages and interest rates have significant effects on manufacturing employment growth. The results suggest that the government can reduce the adverse effects of exchange rate volatility on manufacturing by adopting macroeconomic policies that minimise exchange rate volatility and policies that promote employment creation, for instance, less restrictive policies given that the results show that an increase in interest rates leads to a decline in employment.

Coming up with macroeconomic policies that minimise exchange rate volatility requires the knowledge of the causes of exchange rate volatility. As a result, the second paper (Chapter 3) investigates the determinants of exchange rate volatility in South Africa. Few studies investigate the determinants of rand volatility(Arezki, Dumitrescu, Freytag & Quintyn 2014, Farrell 2001). This study contributes to the literature by finding the sources of rand volatility using output volatility, money supply volatility, foreign reverses volatility, commodity price volatility, openness and a dummy for capital account liberalisation as explanatory variables. This is done using GARCH models for the period 1986 — 2013 employing monthly time series data. The advantage of GARCH models is that they are able to model and forecast time-varying variance given that the exchange rate behaves similarly to other asset prices, for example, stock prices. The study tests the hypothesis that economic openness leads to a reduction in exchange rate volatility following Hau's (2002) modifications of the New Open Macroeconomics model of Obstfeld & Rogoff (1995, 1996). South Africa is a good case study following the liberalisation of the capital account in March 1995. The results show that switching to a floating exchange rate regime has a significant positive effect on exchange rate volatility. That is, it increases exchange rate volatility. The results also

show that trade openness reduces exchange rate volatility using the bilateral exchange rate. The results also show that output, commodity prices, money supply and foreign reserves volatilities significantly influences exchange rate volatility. The study also shows that real factors (commodity prices, output and openness) have relatively larger effects on exchange rate volatility compared to monetary factors.

The third paper (Chapter 4) analyses the short run behaviour of the South African rand using daily data. The study contributes to the literature on the causes of exchange rate movements in several ways. First, it uses an event studies approach *a* la Campbell, Lo & MacKinlay (1997) to answer two research questions. First, what is the impact of South Africa's monetary policy announcements on the rand? Second, what is the impact of South African political events on the rand? The advantage of event studies is that they are able to quantify systematically the abnormal or unexpected impact of an economic or political event on asset prices like the exchange rate. Second, the study focuses on an emerging market given that most studies have mainly focused on developed economies. Third, few studies that use event studies in South Africa focus on stock market reaction to announcements. The results finds 8 out of 12 significant cumulative abnormal returns for monetary policy announcements. This suggests that the rand is not only influenced by demand and supply flows but also by news. The study also finds significant cumulative abnormal returns for all the three exchange rates following the Marikana massacre on 16 August 2012 and the release of Nelson Mandela banknotes on 6 November 2012. The ANC elective conference only has significant cumulative abnormal returns using the Rand/US dollar in 2007 and 2012.

Dedication

To my mother, Frozhi Mpofu

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List of Acronyms

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
BCEA	Basic Conditions of Employment Act
BIS	Bank for International Settlements
CEE	Central and Eastern European
CGE	Computable General Equilibrium
CPI	Consumer Price Index
ECM	Error Correction Model
EEA	Employment Equity Act
EGARCH	Exponential Generalised Autoregressive Conditional Heteroscedasticity
EME	Emerging Market Economy
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
IPAP	Industrial Policy Action Plan
LRA	Labour Relation Act
MPC	Monetary Policy Committee
NEER	Nominal Effective Exchange Rate
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least Squares
PP	Phillips Perron
REER	Real effective Exchange Rate
REPO	Repurchase Rate
RER	Real Exchange Rate
RGDP	Real Gross Domestic Product
SARB	South African Reserve Bank
SIC	Schwartz Information Criteria
StatsSA	Statistics South Africa
TGARCH	Threshold Generalised Autoregressive Conditional Heteroscedasticity
UIP	Uncovered Interest Rate Parity
UK	United Kingdom
US	United States
VARs	Vector Autoregressions
VECM	Vector Error Correction Model
WPI	Wholesale price index

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Chapter 1

Introduction

1.1 Introduction and Motivation

Emerging market economies (EMEs) are gaining prominence in the global economy. This exposes some of these EMEs to problems caused or also faced by developed countries. One such example is the currency wars as a result of low interest rates in developed economies which have also caused large short-term capital inflows into EMEs. This has caused fluctuations in the exchange rates of EMEs. Moreover, empirical evidence shows that fluctuations in exchange rates can cause distortions in the economy. For example, exchange rate volatility creates uncertainty in macroeconomic policy formulation, investment decisions and trade flows(see e.g. Arize, Malindretos & Kasibhatla 2003, Hodge 2005, Musonda 2008, Hausmann 2008, Demir 2010). Consequently, there is a need to investigate the effects and causes of such exposures to EMEs given that these countries have different characteristics compared to developed countries.

South Africa is an example of an EME and exhibits interesting characteristics that make it a good case study. For example, the South African economy liberalised its capital account in mid-1990s. This led its currency to be one of the most traded emerging market currencies and the most traded currency in Africa. Some researchers (see e.g. Ricci 2005, Arezki et al. 2014) have hypothesised that South Africa's currency is volatile due to increased openness. As such, finding the effects and causes of exchange rate volatility in EMEs will assist the policymakers in these countries in formulating appropriate macroeconomic policies.

This thesis focuses on the effects and causes of exchange rate volatility in South Africa. These issues are discussed in three papers, where each paper constitutes a chapter. The first paper (presented in Chapter 2) analyses the impact of real exchange rate volatility on employment growth in South Africa with a focus on the manufacturing sector. The focus on

the manufacturing sector is motivated by some studies (Rodrik 2008, Faulkner, Loewald & Makrelov 2013) which state that the manufacturing sector is vital in the overall performance of the South African economy in terms of output growth and employment creation. Studies by Belke & Setzer (2003) and Belke & Kaas (2004) indicate that employment decisions have the same characteristics as the behaviour of investment expenditures in the presence of rigidities, that is, they are branded by some degree of irreversibility. As a result, the increase in exchange rate volatility will reduce employment growth. In the case of South Africa, no study to the best of my knowledge analyses the effects of exchange rate volatility on manufacturing employment growth.

Chapter 2, therefore, fills this gap. Using an Autoregressive Distributed Lag (ARDL) cointegration method given its advantage of having good properties that enable consistent estimations in small sample sizes. This is due to the short period covered in this study. The study finds that real exchange rate volatility has a significant contractionary effect on manufacturing employment growth. Two models are estimated. One uses bilateral rand/US dollar to measure exchange rate volatility and the other uses the real effective exchange rate. The results suggest that a one standard deviation increase in the real exchange rate volatility reduces employment growth by about 0.98% using the bilateral exchange rate while employment decreases by about 0.87% when using the multilateral real exchange rate volatility. The results also show that output, wages, real exchange rate level and long term interest rates have significant effects on manufacturing employment. Output has the positive sign and the largest magnitude while wages and interest rate negatively affects employment growth. The results suggest that macroeconomic policies that enhance output in the long run should be implemented. The results also suggest that the government can reduce the negative effects on manufacturing employment by adopting measures that minimise real exchange rate volatility. Coming up with such measures requires the knowledge of the causes of exchange rate volatility.

The second paper (presented in Chapter 3) focuses on the determinants of exchange rate volatility in South Africa. This study is motivated by the fact that South Africa liberalised its capital account in March 1995 following the switch to a floating exchange rate regime. Following the evidence since the collapse of the Bretton Woods system, the economies that switched from fixed to floating exchange rate regimes witnessed their exchange rates becoming more volatile (see e.g. Calderón 2004, Caporale, Amor & Rault 2009). As such some researchers (see e.g. Ricci 2005, Arezki et al. 2014) have hypothesised that the subsequent increase in South Africa's exchange rate post March 1995 is due to increased openness. However, empirical studies find conflicting results on the relationship between openness and exchange rate volatility(Hau 2002, Calderón 2004, Bleaney 2008, Amor & Sarkar 2008, Caporale et al. 2009, Chipili 2012). The study follows the modified version of the New Open Macroeconomic Model of Obstfeld & Rogoff (1996) by Hau (2002). This theoretical model

asserts that there should be a negative relationship between exchange rate volatility and openness. That is, more open economies should have less exchange rate volatility. As such, this chapter tests the hypothesis, did economic openness in March 1995 decrease exchange rate volatility in South Africa.

This chapter is also motivated by the fact that few studies examine the determinants of exchange rate volatility. For instance, Arezki et al. (2014) only analyses the relationship between rand volatility and gold price volatility. However, many variables affect the level exchange rate of the rand(Aron, Elbadawi & Kahn 1997, MacDonald & Ricci 2004, Frankel 2007, Saayman 2007, Faulkner & Makrelov 2008). As such this study also investigates other macroeconomic factors that might cause rand volatility. This study is also motivated by the fact that in South Africa, there is evidence of exchange rate volatility having significant effects on macroeconomic factors such as trade and employment (see e.g. Todani & Munyama 2005, Mpofu 2013, Aye, Gupta, Moyo & Pillay 2014).

Using a GARCH(1,1) and an EGARCH(1,1) models for the period 1986 to 2013, the study finds that switching to a floating exchange rate system increases exchange rate volatility given the significance of the dummy variable for the liberalisation of South Africa's capital account in March 1995. The results also indicate that economic openness reduces exchange rate volatility using the bilateral exchange rate of rand/US dollar while using effective exchange rate, the results suggest that economic openness for South Africa with some of its trading partners is less open. The study also finds that output, commodity prices, money supply and foreign reserves volatilities significantly influences rand exchange rate volatility. The results also indicate that real factors (commodity prices, output and openness) have higher magnitudes compared to monetary factors (money supply and foreign reserves). These results suggest that the South African government should focus more on real factors if they aim to reduce exchange rate volatility. However, the results show that the EGARCH's asymmetric term is insignificant for 4 out of 5 different specification of exchange rate volatility. This suggests that the impact of news is not effective at monthly level. This is inline with the efficient market hypothesis which asserts that the effect of news on asset prices like exchange rates clears fast and immediately such that using monthly frequency might result in the news effect being less effective. The results, hence, suggest that there is a need to analyse the behaviour of the exchange rate volatility at either intraday or daily frequency.

The third paper (presented in Chapter 4) analyses the short run behaviour of the South African rand using daily data. This is motivated by the fact that the asymmetric term of an EGARCH model in chapter 3 was not significant at monthly level. However, the efficient market hypothesis informs us that the impact of news reacts quickly on assets prices like the exchange rate. For example, studies by Chipili (2012) and Jabeen & Khan (2014) find that the asymmetric term is insignificant using the TGARCH model at monthly frequency whilst

Stancık (2007) finds that the TGARCH's asymmetric term is significant using the daily data. As such, this study investigates the questions; what is the impact of South Africa's monetary policy announcements on the rand? and do political events have an impact on the rand? The study contributes to the literature by using an event studies approach a la Campbell, Lo & MacKinlay (1997) and focusing on an emerging market given that most studies done have been mainly on developed economies. This is motivated by the fact that few studies that use event studies in South Africa have only been restricted on the behaviour of stock prices(see e.g. Meznar, Nigh & Kwok 1998, Gladysek & Chipeta 2012, Gupta & Reid 2013). The study focuses on the period post the adoption of the inflation targeting system given that the monetary authorities assert that they do not target any exchange rate level yet their actions might affect the exchange rate which then affects the performance of the economy. To examine the immediate response of the exchange rate to monetary policy announcements requires the use of a narrow event window. The study achieves this via careful reading of the central bank statements after each monetary policy committee meeting and South Africa's economic releases on Bloomberg to ensure that no other announcements or events took place on the same day as the monetary policy announcements.

The analysis shows that 8 out of 12 monetary policy announcements resulted in significant cumulative abnormal returns. Implying that monetary policy announcement do affect the movements of rand. Chapter 4 further finds significant cumulative abnormal returns on the three exchange rates used following the Marikana event on 16 August 2012. The rand/US dollar is significant at 5% while rand/pound and rand/euro are significant at 1%. The positive effect found implies that the Marikana event had significant depreciation effects on all the three exchange rates. The depreciation is taken a negative/bad effect given it signals the loss of value of the domestic currency while an appreciation is taken as a positive/good effect. The release of Nelson Mandela banknotes on 6 November 2012 had significant and negative effects on all the three exchange rates. The negative effect, implies the appreciation of the three currencies. As for ANC elective conferences in 2002, 2007 and 2012, the results find that the rand/US dollar only has significant cumulative abnormal returns for 2007 and 2012. These results suggest that the South African rand also responds to some political events.

1.2 Organisation of the Thesis

This chapter has established the main motivations and contributions of this thesis, the rest of the thesis is organised as follows. Chapter 2 analyses the impact of real exchange rate volatility on employment growth with a focus on manufacturing sector. Using an Autoregressive Distributed Lag (ARDL) cointegration method, the chapter shows that an increase in

real exchange rate volatility significantly reduces employment growth in the manufacturing sector. The study also shows that manufacturing output and wages, real exchange rate level and interest rates have significant effects on manufacturing employment.

Chapter 3 investigates the determinants of exchange rate volatility in South Africa. Using GARCH models the study establishes that switching to a floating exchange rate regime increases exchange rate volatility. The study also shows that openness; output, commodity prices, money supply and foreign reserves volatilities significantly influences exchange rate volatility.

Chapter 4 tests whether the rand exchange rate responds to political and macroeconomic news. Using daily data, the study applies an event study approach to find the impact of South Africa's monetary policy announcements on the rand and the impact of major political events on the rand. The study finds that the rand/US dollar, rand/British pound and rand/Euro significantly responds to South Africa's monetary policy announcements. The results also find that the rand also responds to political events.

Finally Chapter 5 concludes the thesis by summarising the main findings of the three papers and discussing their policy implications. It also highlights possible areas for future research which arise from the findings of the thesis.

Chapter 2

Real Exchange Rate Volatility and Employment Growth in South Africa: The Case of Manufacturing

2.1 Introduction

One of the concerns to the policymakers in South Africa is the persistently high unemployment rate. Several factors may explain why unemployment rate has remained high, these include; an increase in labour supply after the end of apartheid, skill-biased technical change,the role of trade unions and bargaining councils, labour regulation and the nature of economic growth (see e.g. Fedderke & Mariotti 2002, Banerjee, Galiani, Levinsohn, McLaren & Woolard 2008, Bhorat 2007). However, to what extent can real exchange rate volatility be made responsible for the negative developments in the South African labour markets?

The issue of exchange rate volatility influencing employment has been much limited. While the limited literature has mainly focused on developed economies such as the USA and German labour markets, probably due to data availability, recent attention has also focused on emerging markets such as Turkey. As a result, this study contributes to the literature on the employment effects of exchange rate volatility in emerging markets. To the best of my knowledge, no study has been done in South Africa that analyses this issue in any great detail[1].

This is done by using an Autoregressive Distributed Lag (ARDL) cointegration method which is able to estimate an error correction form of the model for the variables under

[1] Only Ngandu (2008) using a CGE model, investigates the impact of exchange rate level on employment in all sectors.

investigation. This enables one to analyse the relationship between exchange rate volatility and employment growth. The ARDL cointegration method has the advantage of having nice properties that enable consistent estimations in small sample sizes given the short period covered in this study. The exchange rate movements are expected to impact employment via the profitability of the sectors in export-oriented activities. This is so because exchange rate volatility changes the production costs of firms and thus causes uncertainty of future earnings. This is thought to potentially impact on labour allocation within industries following the notion of option value of waiting(Dixit 1989).

Several factors motivate this study. Firstly, some researchers, for example, Rodrik (2003) assert that a competitive and stable real exchange rate is crucial for economic development. This implies that the next step is to assess its role in creating environments conducive for employment creation. For South Africa, the relationship between exchange rate volatility and employment could be important and relevant in assisting the government's policy of job creation given that South Africa has one of the highest unemployment rates in the world and its currency is regarded as being more volatile compared to other emerging markets.

Secondly, figures 2.4 and 2.5 (to be analysed later under descriptive statistics) indicate that manufacturing value added as a percentage of GDP has had a substantial steady decline between 1995-2010 while the export performance of manufacturing has had an upward trend. Yet its employment share in total non-agricultural employment has stagnated. This contrasting transformation makes it an interesting case study to explore whether exchange rate volatility could have played a role in the observed decline in the share of manufacturing[2].

Thirdly, the study focuses on manufacturing sector because this sector is vital to both growth and employment creation in most economies. For example, the past growth miracles of Japan and the East Asian Tigers (Singapore, Hong Kong, South Korea and Taiwan) provides evidence of how their export-oriented manufacturing sectors were influential in facilitating economic development and growth. For South Africa, Rodrik (2008) states that understanding the dynamism of the South African manufacturing sector will be vital to both economic growth and employment creation. Faulkner et al (2013) state that increasing growth and employment in the manufacturing sector is a much discussed topic in the policy debate which requires supporting policy measures. As such this study aims to find possible solutions to the unemployment problem in South Africa through the impact of macroeconomic factors on the manufacturing sector. The manufacturing sector remains an important part of South African economy, accounting for the largest share of the production sectors of the economy[3](see figure A.1 in the appendix). With this large share, the manufacturing sector

[2]This concept is referred to as a sign of de-industrialization in Africa. See an article by Margaret McMillian, a Professor of Economics at Tufts University, a Senior Research Fellow at IFPRI and a Research Associate at the NBER cited here: http://www.thisisafricaonline.com/News/The-Myth-of-de-industrialisation-in-sub-Saharan-Africa?ct=true

[3]These production driven sectors include: Agriculture, Forestry and Fishing; Mining and Quarrying;

in South Africa has the potential to generate significant spillover effects to the rest of the domestic economy. This follows Tkalec & Vizek (2010) who state that the significance of the manufacturing sector stems from the fact that it is the carrier of innovation, research and development activities that eventually spillover to other sectors and result in increased output.

The vitality of the manufacturing sector is supported by South Africa's Minister of Trade and Industry by saying, " The overriding goal of the Industry Policy Action Plan (IPAP) in the policy context is to prevent industrial decline and support the growth and diversification of South Africa's manufacturing sector. The balance of international evidence is that manufacturing is the engine of growth and employment of all economies that have achieved high gross domestic product (GDP) and employment growth.... Manufacturing can generate significant job creation directly as well as indirectly in a range of primary and service sector activities"[4].

Following the international evidence which shows manufacturing as the engine of growth and employment leads me to compare South Africa and other least developed countries which have built their successes on a dynamic manufacturing sector. One such country is Malaysia. In the mid-1980s South African and Malaysian economies were similar by having identical output per head, total factor productivity, dependence on mining and human capital levels which were very close. Table A.1 shows these figures. However, the evolution of these two countries diverged as time progressed. Rodrik (2008) shows that South Africa's economy had roughly 12 percent of its total labour force employed in the manufacturing sector whilst Malaysia's was less than 8 percent in the mid-1980s. But by the year 2000, Malaysia's workforce reached 16 percent whilst South Africa's dropped to about 7 percent. Moreover, Malaysian industrialization experience came after a period of what looked like a continuous downward trend in manufacturing in the early 1980s. Rodrik (2008) argues that it is possible to reverse a deterioration trend in manufacturing performance by utilising adequate policy framework.

The key findings of the study are that real exchange rate volatility has a significant contractionary effect on manufacturing employment . The results also show that manufacturing output, wages; RER and long term interest rates have significant effects on manufacturing employment. The results suggest that macroeconomic policies that enhance output and reduce exchange rate volatility should be implemented in order to increase employment growth in the manufacturing sector.

The rest of the paper proceeds as follows: Section 2.2 discusses the literature review. Section

Manufacturing; Electricity, Gas and Water; and Construction. The other sectors are for services.

[4]The Department of Trade and Industry 2013, Industrial Policy Action Plan, Economic Sectors and Employment Cluster, IPAP 2013/14 — 2015/16. Cited at http://www.thedti.gov.za/news2013/ipap_2013-2016.pdf

2.3 shows the theoretical model that links exchange rate volatility and the labour market. Section 2.4 defines the data and variables used. Section 2.5 describes the descriptive statistics. Section 2.6 defines the econometric approach used while section 2.7 discusses the results. Section 2.8 concludes.

2.2 Literature Review

Exchange rate volatility affects employment via investment because investment is an important component of demand (Belke & Gros 1998, Belke & Gros 2002). This is also because employment decisions are branded by some degree of irreversibility in the presence of structural rigidities (Belke & Setzer 2003). This follows from the fact that hiring workers also represents an investment in the sense that there are costs incurred to reversing this decision because such a decision is like a sunk cost that cannot be recovered or easily reversed should market conditions change badly, which is also observed with investment expenditures(Caballero & Pindyck 1996).

The relationship between exchange rate volatility and employment is stimulated from the theory of uncertainty in exchange rate and investment. Exchange rate uncertainty has a negative impact on investment process when investment is characterised by irreversibilities because uncertainty increases the value of the option to wait until the next period before investing and hence affecting employment decisions. Belke (2001) calls this transmission mechanism of exchange rate volatility as the investment channel and states that its relevance is determined by the openness of the economy. However, what does the empirical literature linking exchange rate volatility and employment growth say in the presence of rigidities?

Demir (2010) uses a variety of specifications and estimation techniques to analyse the impact of real exchange rate volatility on employment growth in Turkey. He uses a panel of private firms which account for 26% of total value added in the manufacturing sector over the period 1983 to 2005. His study uses three measures of volatility namely: annual standard deviation of the log difference of monthly multilateral real exchange rate (RER), 12 month moving standard deviation of the RER and GARCH(1,1). With those three measures, he finds that real exchange rate volatility has a significant contractionary employment effect on manufacturing firms. Demir (2010) states that the majority of empirical studies suggests an unambiguously direct and negative link from volatility and uncertainty to investment. This is because firstly, increasing volatility can reduce the total supply of credit available from the banking system as cited by Bernanke and Gertler (1990). Sharpe (1994) shows that in markets with capital market imperfections, financial constraints significantly affect firm level fluctuations in employment.

Secondly, increasing exchange rate volatility causes higher interest rates. The interest rates represents the monetary policy channel and the rise in them might represent a restrictive monetary policy which attracts capital flows in the presence of current account deficits and fights against inflation. As a result, increasing interest rates negatively affects employment because this causes the borrowing costs to rise and hence investments of all kinds may be reduced including the hiring of new employees (Nickell & Nicolitsas 1999). In addition, exchange rate volatility can also raise inflation uncertainty (Demir 2010). However, Seyfried & Ewing (2001) show that inflation variability reduces employment while Grier & Grier (2006) show that inflation variability reduces output growth. Thirdly, exchange rate volatility can directly affect firm's employment decisions through its effects on sales, profits and investment risk and planning[5]. This is similar to what Obstfeld & Rogoff (1995) show that if goods prices are sticky then monetary shocks can have persistent real effects on consumption, output and exchange rates due to wealth effects from changes in the current account.

Similar results are obtained by Belke & Kaas (2004) while examining the impact of real exchange rate volatility and total economy employment growth in Central and Eastern European (CEE) countries. Their study, however, employs a cross-country panel analysis and finds that real exchange rate volatility reduces employment growth using the standard deviation of the 12 month-to-month changes in the logarithm of the RER and real effective exchange rate (REER)[6] as the measure of volatility. They state that another transmission channel of exchange rate volatility and employment is via higher wages. This follows that uncertainty in labour demand may cause unions to negotiate higher wages for their members and lead to higher unemployment. This is similar to the findings by Andersen & Sørensen (1988) indicating that increased exchange rate volatility increases real wages and lowers employment.Belke & Göcke (2001) using employment index also find the negative relationship between exchange rate volatility and employment performance.

Using a different approach i.e. examining the impact of exchange rate volatility on unemployment instead of employment growth,Belke & Setzer (2003) find that exchange rate volatility increases the unemployment rate. Their study analyses the labour markets in the four Visegrand economies (Czech republic, Hungary, Poland and Slovak republic) using a cross-country panel analysis. The same procedure is done by Stirböck & Buscher (2000) who also find similar results. Belke & Gros (2002) use vector autoregressions (VARs) in first differences to analyse the impact of exchange rate volatility on employment growth and changes in unemployment for the period 1973 to 1999 in Germany. Their study finds that an increase in exchange rate volatility reduces employment growth and increases the unemployment rate. Their study uses different measures of exchange rate volatility but follows

[5]See also Sharpe 1994 about the effects of sales on employment.

[6]The same measure of volatility is used in other studies involving Belke e.g Belke & Setzer(2003), Belke & Gros(2002) and Belke (2001).

Gros (1996) whose study finds that a 1% increase in exchange rate volatility raised the unemployment rate by 0.6% and a decline in employment growth of 1.3% in Germany over the period 1971 to 1995.

The paper that uses a similar methodology as the one used by this paper is the study by Belke (2001). Belke uses the labour demand equation extended to the open economy case for Germany from 1973Q4 to 1996Q2. He finds that exchange rate volatility has a negative effect on total economy employment. This paper differs with Belke's in that it focuses on manufacturing employment unlike the employment in the entire country. As such the choice of variables also differs i.e this paper uses manufacturing output unlike RGDP which represents the output for the entire country as done by Belke (2001). This paper also uses real interest rate instead of the oil prices as used by Belke (2001). The reason for focusing on manufacturing sector is because it is a major source of employment expansion in South Africa given that it has a large number of unskilled workers. Hence the poor performance of the manufacturing sector contributes significantly to South Africa's unemployment problem. Moreover, manufacturing data on employment is consistent unlike the employment data for the entire economy[7].Based on these studies, the empirical literature tells us that there is a negative relationship between exchange rate volatility and employment growth.

Most empirical work on the impact of exchange rate volatility on employment performance or unemployment rate has focused on developed countries with only a few on developing countries as shown above. Despite the fact that several papers have been written that analyse why unemployment rate has remained high in South Africa, no empirical study has focused on explaining the impact of exchange rate volatility on employment growth. As such, this paper contributes to the analysis of the impact of exchange rate volatility on employment growth in developing countries. The studies in developing countries have examined mostly the impact of the real exchange rate level on employment performance or the unemployment rate.

For instance,Frenkel & Ros (2006) using Ordinary Least Squares (OLS) find that RER appreciation increases unemployment in four Latin American countries namely; Argentina, Brazil, Chile and Mexico. Frenkel (2004) whose study analyses the same countries examined by Frenkel & Ros (2006) asserts that RER affects employment in the short run by its influence on determining the activity level. Similar effects of RER are found in other studies as well (see e.g. Kim 2005, Faria & Leon-Ledesma 2005, Goldberg & Tracy 2001).

In South Africa, Ngandu (2008) investigates the impact of exchange rate on employment in all sectors using a Computable General Equilibrium (CGE) model. He concludes that there is an overall positive impact on employment from an appreciation of the exchange rate. This

[7]See Bhorat & Oosthuizen (2008) for details on the sectors omitted in the calculation of the indices for employment for the entire South African economy.

is so because some sectors do better than others and manage to offset the employment loss in worse off sectors. For example, his results show that the services sector does better in its employment and offsets the employment losses in the manufacturing sector which has a negative relationship with the exchange rate. However, he asserts that his methodology has a disadvantage of not being able to tackle dynamic issues that arise such as currency changes (i.e. CGE models are static). This study will utilise a methodology which tackles this problem.

Galindo, Izquierdo & Montero (2007) use a panel data analysis to test whether real exchange rate fluctuations have a significant impact on employment, and whether the impact varies with the degree of trade openness and liability dollarization in 9 Latin American countries. They find that real exchange rate depreciation increases employment growth in countries with high degrees of trade openness. They argue that increased openness in financial markets implies that emerging market economies are exposed to big swings in capital flows, and that these swings causes large fluctuations in real exchange rate which have important micro and macro-economic implications. However, their findings are reversed as liability dollarization increases because the effects of the RER depreciation can be negative if a significant amount of debt is denominated in foreign currency. For instance, it may lead to the reduction of the firms' net worth. According to Galindo et al. (2007), the financial accelerator literature states that the probability of bankruptcy increases when the ratio of debt over net worth increases. These examples justify why the RER is included in the econometric model later.

2.3 Exchange Rate Volatility and the Labour Market

The model of Belke & Setzer (2003) illustrates the relationship between exchange rate volatility and employment growth. Their model is based on the notion that uncertainty of future earnings raises the option value of waiting with decisions which concern investment projects as cited in Dixit (1989).

In the Belke & Setzer (2003) model, there are 3 periods T=0,1,2 and a firm in the export-oriented industry that decides about job creation. Creating the job in period 0 implies the worker is hired for two periods (0 and 1) to produce output to be sold in periods 1 and 2. If the job is created in period 1 then the worker is hired only for period 1 and output is sold in period 2. To create a job, the firm pays a start-up cost which reflects the cost of hiring, training and the provision of job specific capital. The worker is paid a wage rate above the worker's fallback or reservation wage during every period of employment. The reservation wage measures disutility of work and all opportunity income that a worker has to give up by accepting the job. This includes unemployment benefits, collective wage set by a trade union or to a minimum wage, all of which raises the worker's fallback position.

In every period the worker produces output to be sold in the following period in a foreign market at domestic price p which has a certain component p*(the foreign price) plus a stochastic component ϵ (the exchange rate). The model assumes that the exchange rate follows a random walk because random walk models perform better in out-of-sample forecasting as asserted by Meese & Rogoff (1983). The exchange rate in period 1 (ϵ_1) is uniformly distributed between -σ_1 and +σ_1. The exchange rate in period 2 (ϵ_2) is uniformly distributed between $\epsilon_1 - \sigma_2$ and $\epsilon_1 + \sigma_2$. An increase in σ_i where $_i$ refers to period 1 and 2, means an increase in uncertainty (σ_i is proportional to the standard deviation of ϵ_i). Uncertainty can be temporary if $\sigma_1 > 0$ and $\sigma_2 = 0$ or persistent if $\sigma_2 > 0$ as well. The wage rate is determined by bargaining solution that maximizes the product of the worker's and firm's expected net return from the job. Both the worker and the firm are risk neutral implying they both bargain about a fixed wage rate which is independent of realizations of the exchange rate so that the firm bears all the exchange rate risk.The bargaining power of the worker is denoted by $\beta \in (0, 1)$.Thus the expected net return for a job created in period zero is

$$E_0(\pi_0) = 2(1 - \beta)\pi - c \tag{2.1}$$

Where c is the start-up cost. The model assumes that the firm and the worker sign a binding employment contract for two periods (0 and 1) so that job termination is not an option in case the exchange rate turns out to be unfavourable. If the firm waits until period 1, it will create a job only if the exchange rate realized during period 1 and expected for period 2 is above a certain threshold denoted by ζ. With this, the expected net return for creating a job is

$$E_0(\pi_1) = \frac{(1 - \beta)(\sigma_1 - \zeta)^2}{4\sigma_1} \tag{2.2}$$

In equation 2 an increase in exchange rate volatility raises the value of waiting due to the equation being an increasing function of σ_1. Hence the option not to open the job becomes more valuable with more uncertainty. Using equation 1 and 2, Belke & Setzer (2003) state that the firm prefers to wait if and only if

$$\frac{(1 - \beta)(\sigma_1 - \zeta)^2}{4\sigma_1} > 2(1 - \beta)\pi - c \tag{2.3}$$

As the left hand side is increasing in σ_1, the firm delays job creation if the exchange rate volatility is large enough. Further restriction proposed in Belke & Setzer(2003) is that

equation 3 will hold with equality at the following critical value

$$\sigma_1^* = 3\pi - \frac{c}{1-\beta} + 2\sqrt{\pi(2\pi - \frac{c}{1-\beta})} \tag{2.4}$$

whenever $\sigma_1 > \sigma_1^*$, firms decide to postpone job creation in period 0. Since σ_1^* is increasing in π and decreasing in the reservation wage w, decreasing in the cost of job creation c and decreasing in the worker's bargaining power β, the model by Belke & Setzer (2003) asserts that there will be a negative relationship between exchange rate volatility and employment if the labour market is characterized by rigidities that raise the option value of waiting and advocates for the postponement of job creation. An important implication of the model is that even the current i.e short term uncertainty σ_1 can have a strong and lasting effect on the decision to wait(Belke & Gros 1998). Hence, the methodology such as cointegration that is able to separate between short run effects and long run effects, implies that the negative impact of exchange rate volatility on employment growth is stronger in the short run than the long run. This follows Belke (2001) who asserts that, " We are, however, somewhat puzzled by the fact that variability has an impact on employment even in the long run and that the size of the long run effect seems to be so strong".

Moreover, a variety of economic models (see e.g. Belke & Gros 1998, Belke 2001) indicate that employment decisions are discouraged by exchange rate volatility in the presence of rigidities. Demir (2010) further supports this notion by asserting that the level to which the employment decisions are subject to the irreversibility problem is conditional on the degree of labour market flexibility.

The question that then arises is, does this apply to the South African economy? According to the model by Belke & Setzer (2003), the relationship between exchange rate volatility and employment should be strong if the labour market is characterised by rigidities which improve the bargaining position of the workers. The labour markets in South Africa are broadly considered to be rigid to give the scope to the functioning of the mechanisms derived from the model. For instance,the study by Bhorat & Cheadle (2009) shows that in the late 1990s hiring (measures all social security and health costs) and firing (financial and legislative provisions for retrenching workers) costs were fairly rigid while hiring (employment contracts) and firing(dismissal clauses) regulations were flexible. However, by 2006 the South African economy was characterised by high levels of hiring and firing rigidities but with flexible hiring and firing costs. This is due to high values of hiring and firing rigidities(44.00 and 40.00 respectively for South Africa vs 29.91 and 33.43 respectively for upper-middle income countries),and low values of hiring and firing costs for South Africa relative to other upper-middle income countries and the global averages using the World Banks' Cost of Doing Business (see table 1).

Table 2.1: Mean Measures of Regulation, by Income level

Area of Regulation	UMI	South Africa	Global average
Rigidity of Hiring	29.91	44.00	34.33
Rigidity of Hours	40.57	40.00	42.40
Rigidity of Firing	33.43	40.00	33.26
Aggregate Employment Index	34.64	41.33	36.66
Hiring Costs	17.31	2.40	15.62
Firing Costs	44.63	24.00	51.34

Source: Bhorat & Cheadle (2009)

Note: UMI refers to Upper Middle Income Countries. The numbers range from 0 to 100. The higher the number then the more rigid is the category in question.

Emphasis is placed on hiring and firing costs, and hiring and firing rigidities because empirical studies linking the theory of labour market rigidities and unemployment find that these rigidities have the strongest and most significant effect (Bernal-Verdugo, Furceri & Guillaume 2012, Nickell 1997). Besides, Nickell (1997) states that some rigidities do not cause high unemployment. For instance, he finds that rigidities such as union density, union coverage index and employment protection index (strength of the legal framework governing hiring and firing) have the strong impact on unemployment, meaning having these rigidities increases unemployment. However, he finds that rigidities such as the tax burden on labour, the unemployment benefit system and working time have either no impact or little impact on unemployment.

Moreover, the labour laws in South Africa improve the bargaining position of the workers. The main labour laws in South Africa include the Labour Relations Act (LRA) 66 passed in 1995, the Basic Conditions of Employment Act (BCEA) 75 passed in 1997 and the Employment Equity Act (EEA) 55 passed in 1998. The LRA is the centerpiece of labour law and all other labour laws are subordinate to this law. The LRA states that every worker has the right to form and join a trade union, to participate in the activities and programmes of a trade union and to strike. The BCEA addresses issues such as hours of work, overtime, meal intervals, annual leave, sick leave and remuneration to mention but a few. The EEA promotes equal opportunity and fair treatment as well as affirmative action to redress racial imbalances that negatively affected the Black people (Africans, Coloured and Indians), women and people with disabilities[8].

Based on the above model and the trend in the South African labour markets, I can conclude that exchange rate volatility is more likely to have a negative effect on employment growth

[8]These legislations have amendments: as amended by Labour Relations Amendment Act 42 of 1996, Labour Relations Amendment Act 12 of 2002; as amended by Basic Conditions of Employment Amendment Act 11 of 2002. Other Acts mentioned in line with these amendments include: Intelligence Services Act 65 of 2002, Electronic Communications Security (Pty) Ltd Act 68 of 2002, General Intelligence Laws Amendment Act 52 of 2003, Prevention and Combating of Corrupt Activities Act 12 of 2004, Public Service Amendment Act 30 of 2007, and Skills Development Amendment Act 37 of 2008.

in the manufacturing sector because of the increases in job creation costs.

Given that the paper is analysing the impact of exchange rate volatility on employment, the theory used to guide on the econometric technique (i.e the choice of variables) to be formalised in section 6 is the labour demand function. In terms of economic analysis, the most important determinants of labour demand are output, the cost of labour and interest rate[9]. From these basic variables, other variables are then added.

2.4 Data

This paper uses quarterly time series data ranging from 1995 to 2010. This period is chosen because the South African government adopted the floating exchange rate regime in 1995 which exposes the currency to swings. The sources of the data include South African Reserve Bank (SARB), Statistics South Africa (Stats SA),DataStream and OECD. The employment data comes from DataStream. This data is based on sources from Stats SA surveys. The manufacturing employment index data from SARB shows the similar pattern as the data from DataStream,of which the SARB asserts that the index is based on sources from Stats SA. As such, I can say that the time series version of the employment data is consistent. The variables are defined as follows.

The dependent variable is employment (*Lemp*) which is measured as the logarithmic of the number of employees in the formal manufacturing sector. From the literature, it is advisable to test for dynamic effects so that the well-known path dependence of the employment growth is captured. To proxy this, the lagged value of log employment is used.

Real exchange rate volatility (ExrateV) is measured using the moving sample standard deviation. It is a time varying measure of exchange rate volatility that accounts for periods of low and high exchange rate volatility. It is expressed as

$$Vol_t = \left(\frac{1}{m} \sum_{i=1}^{m} [R_{t+i-1} - R_{t+i-2}]^2 \right)^{\frac{1}{2}} \tag{2.5}$$

where R is the rate of change of real exchange rate . m is the order of moving average and I use m=12. Based on the discussion in section 2, I expect a negative relationship between real exchange rate volatility and employment .

Real Exchange rate (RER) is measured as the logarithmic of the real exchange rate . It is

[9]The choice of these variables is based on other studies done in South Africa analysing the labour demand function in the manufacturing sector since this paper is investigating the manufacturing sector. Though not completely related, these examples include Fedderke and Mariotti (2002) and Moolman (2003).

used to control for the level effects and the study uses the direct quotation system (South African rands per U.S dollar), meaning an increase refers to depreciation. Given that the paper analyses for the entire manufacturing sector, both outcomes are possible. That is, I expect a positive or negative relationship between real exchange rate and employment growth i.e depreciation of RER may increase or decrease employment growth. The paper uses CPIs as deflators to come up with the RER from nominal rates.

Output is the logarithmic of manufacturing gross value added at 2005 constant prices and seasonally adjusted. It is used to control for manufacturing demand shocks and productivity changes. I expect a positive relationship with employment growth.

Wages is the logarithmic of real wages in the manufacturing sector at time t-1.Lagged values are used to control for the possibility of contemporaneous effects of exchange rate volatility on employment growth through higher wages and the reverse causality from labour demand (Demir 2010) . I expect a negative relationship between wages and employment growth as economic theory asserts.

Interestr is the interest rate. This paper uses the yield on government bonds-10 years and more which represents the long term interest rates.

Dummy variables (D_i). Find0809 is the dummy variable for the 2008/2009 global financial crisis. This variable takes the value of 1 (one) from 2008-2009 and 0 otherwise. BCEA97 is the labour legislation dummy for the years in which the Basic Conditions of Employment Act was passed. It takes the value of 1 (one) from 1997 onwards and 0 otherwise. EEA98 is the labour legislation dummy for Employment Equity Act. It takes the value of 1 (one) from 1998 onwards and 0 otherwise. The other dummy variable available is the labour relations act (LRA95). However, the LRA95 dummy variable is not used to avert the dummy trap that leads to multicollinearity. These dummy variables are used because it is believed that they have an impact on the labour demand function.

Trend. This variable takes the value of 1 in 1995Q3, 2 in 1995Q4, 3 in 1996Q1 e.t.c. This variable is used to try to capture the impact of technical progress on labour demand.

2.5 Descriptive Statistics

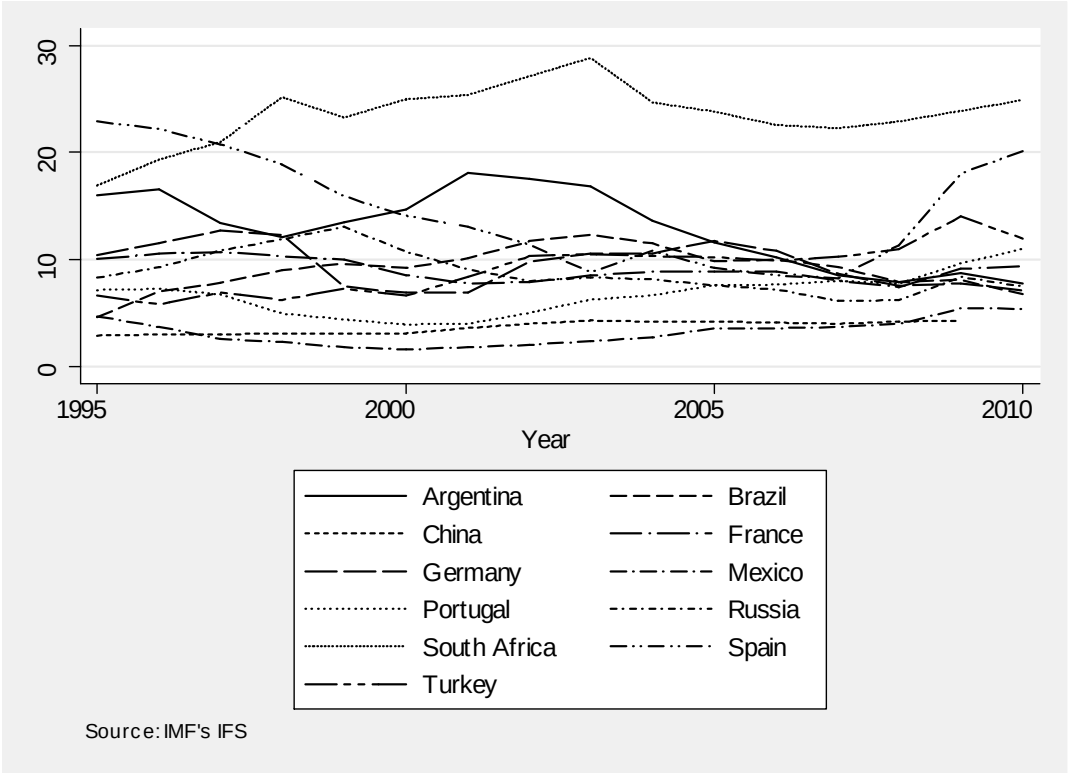
The paper proceeds by providing stylised facts of some of the key labour market and macroeconomic indicators in South Africa between 1995 and 2010.

During this period the unemployment rate increased from 16.90% in 1995 using the narrow definition to 28.85% in 2003 before declining to reach 24.93% in 2010[10]. The narrow

[10]The broad unemployment also increased from 30.8% in 1995 to 41.8% in 2003 before declining to reach

definition of unemployment is used because it is the international comparator to the definition of unemployment formally adopted by the International Labour Organisation in 1982[11]. Although the unemployment rate was on a downward trend since 2003, it is still one of the highest in the world. Figure 1 shows the trend of the unemployment rate in selected countries.

Figure 2.1: Unemployment Trends for Selected Countries 1995 to 2010



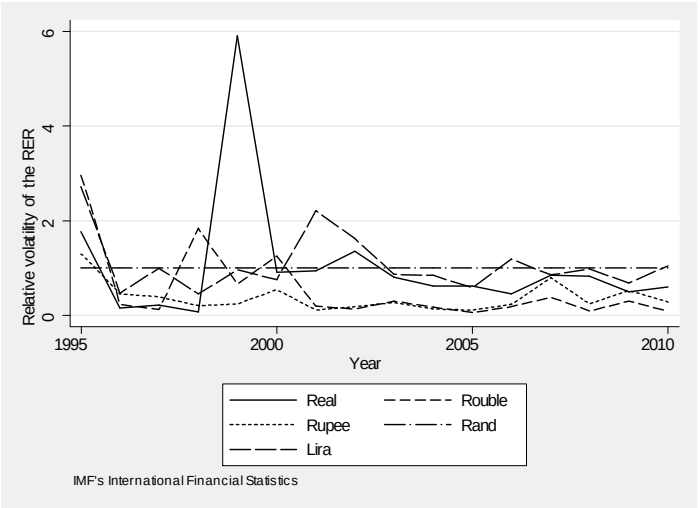
The next issue is how volatile was the rand and the movement in its level during this period. Exchange rate volatility is the tendency of the exchange rate to rise or fall sharply within a short period of time. However, there is no consensus in the literature on how to measure volatility because it is an unobservable variable.The methods widely used are generalised autoregressive conditional heteroscedasticity (GARCH) which allows for time varying conditional variance i.e. volatility clustering mostly observed in high frequency data sets, the moving sample standard deviation and to a lesser extent simple standard deviations. As such this paper will use the moving sample standard deviation in the fully specified regression analysis later on. Using the simple volatility measure i.e. the standard deviation of the monthly percentage changes in the real exchange rate, figure 2 shows that

38% in 2010. See Bhorat (2007) for the trend analysis of the two definitions for the case of South Africa between 1995 and 2006.

[11]Narrow unemployment is defined as unemployed who did not work in the last seven days but actively looked for work whilst broad unemployment is narrow unemployment plus those who were not working but would accept a suitable job if offered even though they are not looking for work now (and in some cases includes seasonal workers and contract workers as well).

the rand is relatively more volatile compared with other emerging market currencies[12]. This is because the volatility of other currencies are on average below one between 1995 and 2010. The few spikes seen are due to major global economic disturbances such as the Asian crises in 1997 and the Mexican crises in 1998.

Figure 2.2: Relative Volatility of the Rand compared to selected emerging markets

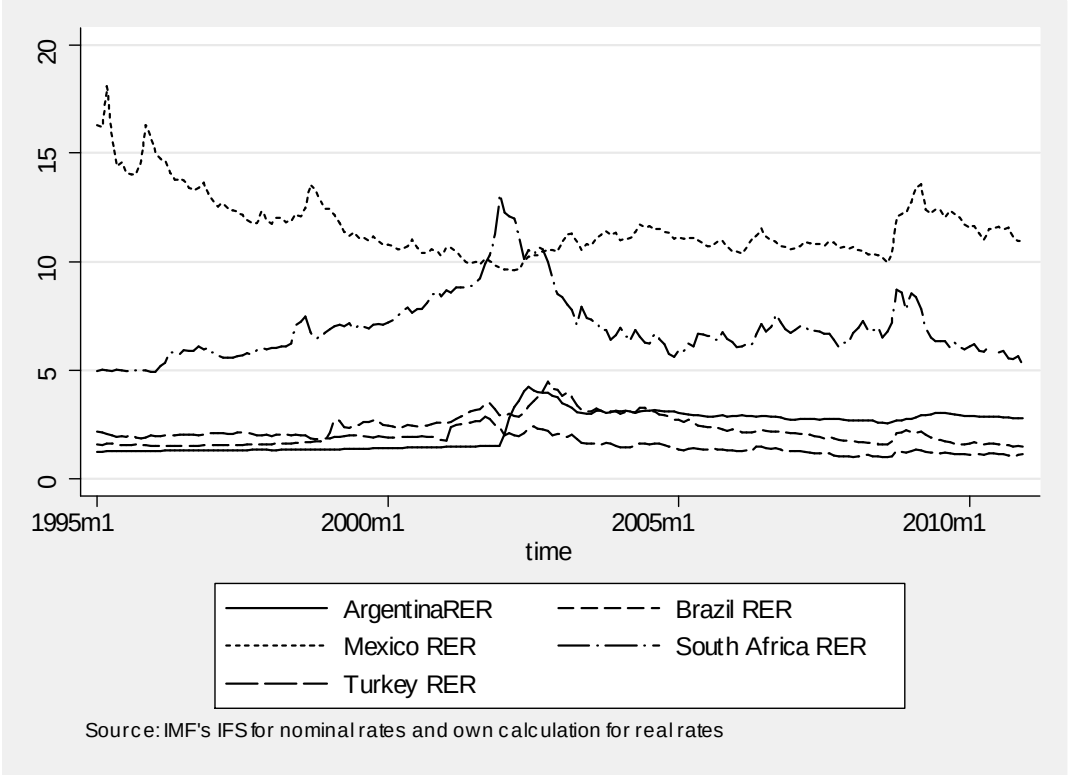


On the other hand, figure 3 shows that the rand per US dollar depreciated between 1995 and 2001, and then appreciated between 2002 and 2010. Relative to other currencies, the rand depreciated at a faster rate between 1995 and 2001 with the exception of the Mexican peso that appreciated during this period. The rand depreciated by about 164% while Brazil, Turkey and Argentina's currencies depreciated by about 87%,7% and 21% respectively. The Mexican currency appreciated by about 40%. Between 2002 and 2010, the rand also appreciated at a faster rate relative to the currencies of Argentina, Brazil and Turkey. During this latter period, the rand appreciated by about 57% unlike Brazil and Turkey's currencies that appreciated by about 50% and 44% respectively, while Mexico's currency depreciated by about 14% . A similar trend of the rand per US dollar is observed for the rand per euro. These two rates (rand/US dollar and rand per euro) are stated because the US dollar is the currency that is widely used in the foreign transactions, and the fact that South Africa trades mostly with the United States of America and the Eurozone. Due to data availability, this paper will use the rand per U.S dollar rate.

But what could have caused the volatility and sustained appreciation of the rand between 2002 and 2010? One explanation is that the rand is volatile because it is the most traded currency in Africa and is also traded as much as other emerging market currencies. This is shown in table 2 by looking at percentage shares of average daily turnovers following the survey by the Bank for International Settlements (BIS) in 2010.

[12]relative volatility calculated as: Foreign currency÷South African currency.

Figure 2.3: Selected emerging market's real exchange rates (domestic currency per US$)



Another possible explanation for the volatility and appreciation of the rand is due to large short term capital flows as a result of relatively higher domestic interest rate because of the relative high rate of return in most emerging market economies. This follows the sluggish recovery in developed economies that have sustained low interest rates. The high interest rates in emerging markets led to increased carry trade volumes into these economies. A carry trade is a trading strategy where one invests in currencies which yield high interest rates and funds this investment by borrowing in currencies with low interest rates. This is due to the failure of uncovered interest parity (UIP) condition which states that exchange rate changes has to eliminate the interest rate margin. Moreover, empirical studies show that exchange rate changes do not compensate for the interest rate margin and that the opposite holds true, that is, high interest rate currencies tend to appreciate while low interest rate currencies tend to depreciate which yields considerable returns to currency speculation (see e.g. Menkhoff, Sarno, Schmeling & Schrimpf 2011, Hassan & Smith 2011).

Overall, the performance of the rand volatility and its level is due to the exchange rate policy followed by the South African Reserve Bank (SARB). South Africa follows a floating exchange rate system since the removal of the dual exchange rate regime in 1995. This means that the rand is determined by the forces of demand and supply. The SARB,however, can participate in the foreign exchange market and such activities can influence the exchange rate. It is because of this reason that the government was under pressure to intervene to

Table 2.2: Selected Emerging Market currency distribution of global exchange market: Percentage shares of average daily turnover

Currency	1998	2001	2004	2007	2010
Korean won	0.2	0.8	1.1	1.2	1.5
Mexico peso	0.5	0.8	1.1	1.3	1.3
Indian rupee	0.1	0.2	0.3	0.7	0.9
Russian rouble	0.3	0.3	0.6	0.7	0.9
Chinese renminbi	0.0	0.0	0.1	0.5	0.9
Polish zloty	0.1	0.5	0.4	0.8	0.8
Turkish lira	.	0.0	0.1	0.2	0.7
South African rand	0.4	0.9	0.7	0.9	0.7
Brazilian real	0.2	0.5	0.3	0.4	0.7
Malaysian ringgit	0.0	0.1	0.1	0.1	0.3
Chilean peso	0.1	0.2	0.1	0.1	0.2
Argentine peso	0.1	.	0.0	0.0	0.0

Source: Bank for International Settlements

influence the currency with the hope of stimulating exports which then increases output and thus positively affecting employment. The SARB asserts that its participation in the foreign exchange rate market is to build up the foreign exchange reserves and should be seen as the management of international liquidity and not the exchange rate policy target. As from the year 2000, the sole objective of the SARB has been inflation targeting. This has led the inflation rate to be volatile. Gupta (2012) states that inflation volatility can impede growth even if inflation on average remains restrained and advocates that the SARB should respond to exchange rate fluctuations.

On the other hand,the manufacturing sector performed poorly during this period. Figure 4 shows that the manufacturing value added as percentage of GDP declined from 21.22% in 1995 to 14.64% in 2010. At the same time, the manufacturing sector has been characterised by falling employment and disappointing export performance(Faulkner & Makrelov 2008). It is disappointing because real manufacturing exports increased during the period under review with slight decreases in 2002/2003 and 2008/2009 period yet manufacturing employment did not increase as exports increased. This contrasting transformation between export performance and employment makes it an interesting case study to explore the effects of real exchange rate volatility and the level of the exchange rate on manufacturing employment. This is due to the fact that the manufacturing exports performed relatively better whilst the employment performance did not follow similar trends yet the exchange rate is also linked to employment via the trade balance. This suggests that the exchange rate might not have been competitive enough (even though it depreciated between 1995 and 2001) to attract more exports from the manufacturing sector.This notion that the RER might not have been competitive enough is supported by the studies which investigates the South African real equilibrium exchange rates (see e.g. Saayman 2007, MacDonald & Ricci 2004). Saayman

(2007) uses the rand per US dollar exchange rate and finds that the currency was overvalued from 1995 to 2002 when the unit labour cost for both foreign and local prices, and wholesale price index (to proxy the price of foreign tradables) and consumer price index(CPI) (to proxy the price of local non-tradables) are used as deflators when calculating the RER. When the CPI for both the foreign and local prices is used, the results indicate that the rand per US dollar was overvalued from 1995 to 2000 only but with a small undervaluation between mid-1998 and early 1999. MacDonald & Ricci (2004) use the real effective exchange rate (deflated using CPI) for South Africa's currency and find that the currency was overvalued from 1995 to 2002Q1 except between 1998Q1 and 1999Q1.

Moreover, Edwards & Alves (2006) state that the lack of re-structuring exports towards the dynamic high technology products is one of the reasons why South African manufacturing exports performed poorly during the 1990s as well as lagging the exports performance of East Asian economies. They also argue that the real depreciation of the rand during the 1990s contributed extensively towards growth in the manufacturing exports but the volatility of the exchange rate may have contributed to the poor export performance relative to other developing economies. Figure 5 shows the trend of manufacturing employment and exports. Moreover, Hausmann (2008) states that the manufacturing sector is one of the sectors mostly intensive in the use of unskilled labour. As such, to achieve greater levels of employment, there is a need for a relative expansion of the tradable sector to create more jobs for low skilled individuals.

To uncover some key stylised facts of the data, table 3 shows the summary statistics.

Table 2.3: Summary Statistics 1995Q3-2010Q4

Variables	Obs	Mean	Std.Dev	Min	Max
Employment	62	14.0697	0.0615	13.9631	14.2022
Volatility	62	2.1806	0.7121	0.9033	3.8032
Volatility2	62	0.0422	0.0165	0.0191	0.0783
RER	62	1.9339	0.1898	1.6074	2.5014
REER	62	4.6461	0.1067	4.3393	4.8049
Output	62	12.3880	0.1364	12.1917	12.6348
Wages	62	5.3831	0.1077	5.1967	5.6539
Interestr	62	4.9532	3.6719	-3.0000	12.5000
Exports	62	12.6841	0.3400	11.9334	13.3222
Invest	62	10.7848	0.2174	10.5231	11.2305

Notes: All variables are in logs except the volatility variable. Variables are as defined in section 4. Obs=number of observations. Std.Dev=standard deviation Min=minimum. Max=maximum.Volatility=volatility using RER. Volatility2=volatility using REER. Source: Output using Microfit 4.1

Figure 2.4: Manufacturing Value Added (% of GDP)

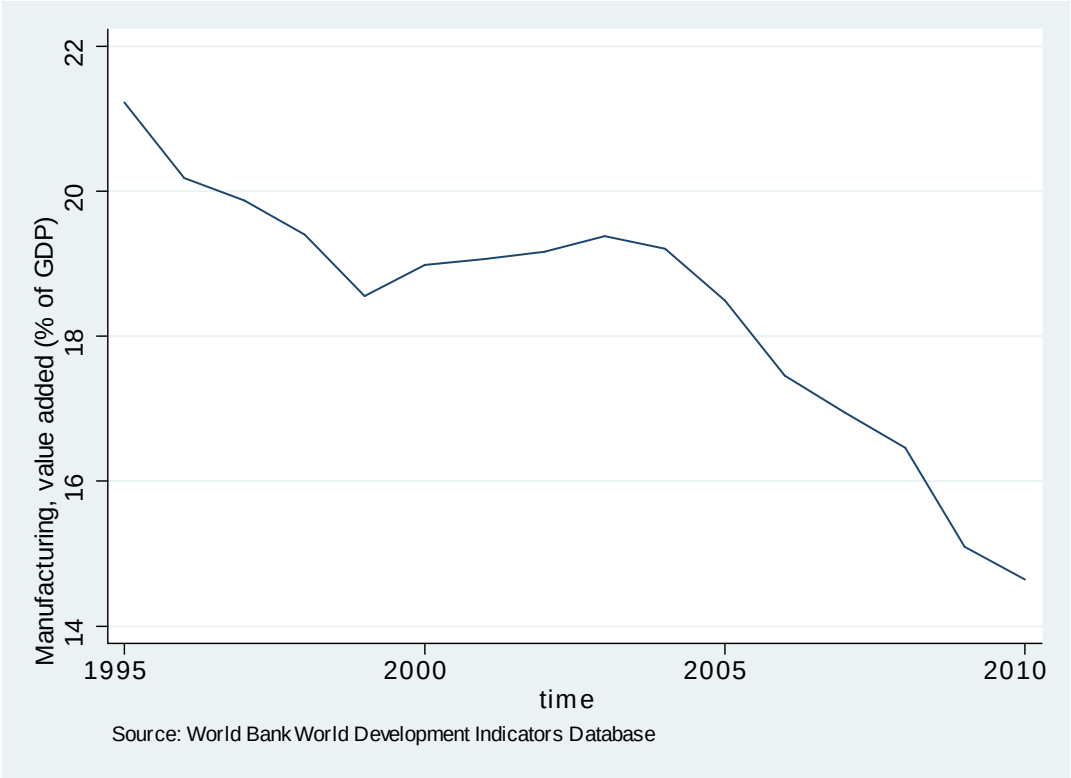
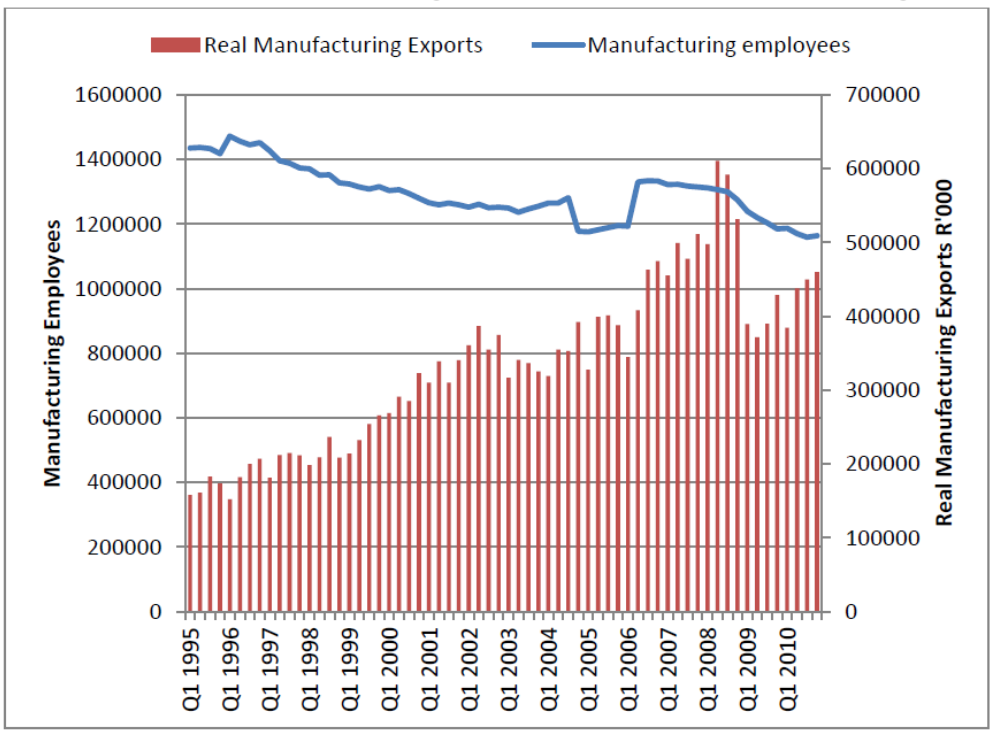


Figure 2.5: Manufacturing employees and real manufacturing exports



Source: DataStream for manufacturing employees. Department of Trade and Industry for nominal manufacturing exports.

Manufacturing PPI index used to deflate manufacturing exports.

2.6 Econometric Approach

To achieve the objective of finding the impact of real exchange rate volatility on employment growth in the manufacturing sector, I use the labour demand equation represented as follows

$$\begin{aligned} \ln Employment_t &= \beta_0 + \beta_1 \ln output_t + \beta_2 \ln wages_t + \beta_3 Interestr_t \\ &\quad + \beta_4 \ln rer_t + \beta_5 ExrateV_t + \beta_6 trend_t + \beta_7 Dummy_t + \varepsilon_t \end{aligned} \tag{2.6}$$

where according to economic theory, the dependent variable should be explained in the long run by the first two variables on the right hand side(RHS) i.e output and wages. The third variable on the RHS (Interestr) is part of the factor prices as explained by Hamermesh (1996) that labour demand adjusts to shocks to product demand and factor prices. Comparing to the existing studies of the South African labour market investigating the manufacturing sector, the use of the interest rate is similar to the user cost of capital as done by Fedderke & Mariotti (2002). From this basic specification, the remaining variables are then added.To estimate equation (6), the paper applies cointegration analysis following Belke (2001).

The Autoregressive Distributed Lag (ARDL) cointegration method is used to estimate the impact of real exchange rate volatility on employment growth in the manufacturing sector for South Africa. This approach allows the estimation of both short run and long run coefficients of a single equation cointegration method. The coefficients of this approach are unrestricted and as such the short run dynamics are not dictated by the long run equilibrium relationship. It has an advantage over other cointegration methods (both single equation cointegration methods e.g. fully modified OLS and dynamic OLS; and non single equation e.g. Johansen 1988) in that it performs better in small samples (Pesaran & Shin 1999). The other advantage is that it works even when the underlying variables are integrated of order zero {I(0)} only, integrated of order one {I(1)} only or a mixture of I(0)/ I(1) unlike the cointegration methods of Engle & Granger (1987),Johansen (1988) and Stock & Watson (1988) that concentrate on cases in which the underlying variables are integrated of order one {I(1)} only (Pesaran, Shin & Smith 2001). Hence the bounds testing procedure by Pesaran et al. (2001) allow to test for the existence of a level long run relationship when the orders of integration of the underlying regressors are not known with certainty. This follows the low power of unit root tests that leads to always be a certain degree of uncertainty with respect to the order of integration of the underlying variables (Belke & Polleit 2006).

Unlike other single equation cointegration methods, ARDL method offers explicit tests for identifying a unique cointegration vector but like the other single equation cointegration methods, it suffers from the weakness that it is only valid when there is a unique cointegra-

tion vector. There is no guarantee that there will always be a unique cointegration vector (Muchapondwa & Pimhidzai 2011). However, it is necessary to put appropriate lags of the regressors in ARDL cointegration method before estimation. Doing so, the ARDL model is advantageous because it simultaneously corrects for residual serial correlation and the problem of endogenous regressors.This appropriate augmentation of the order of the ARDL model leads to two important facts. First, the OLS estimators of the short run parameters are $\sqrt{T}$-consistent with the asymptotically singular covariance matrix. Second, the ARDL based estimators of the long run coefficients are super-consistent. Hence valid inferences on the long run parameters can be made using standard normal asymptotic theory (Pesaran & Shin 1999). It has an additional advantage of yielding consistent estimates of the long run coefficients that are asymptotically normal irrespective of whether the underlying regressors are I(0) or I(1) or mutually cointegrated (Pesaran & Shin 1999).

The test in ARDL model is the standard Wald or F statistic for testing the significance of the lagged levels of the variables in a first difference regression. The regression is an error correction form of an ARDL model in the variables of interest. This paper will estimate the following ARDL model:

$$\begin{aligned} Employment_t &= \alpha_0 + \alpha_1 D_i + \alpha_2 T_t + \sum_{i=1}^{p} \phi_i Employment_{t-i} + \sum_{i=0}^{q} \beta_{1i} ExrateV_{t-i} + \\ &\sum_{i=0}^{r} \beta_{2i} RER_{t-i} + \sum_{i=0}^{s} \beta_{3i} Output_{t-i} + \sum_{i=0}^{t} \beta_{4i} Wages_{t-i} + \sum_{i=0}^{y} \beta_{5i} Interestr_{t-i} \\ &+\varepsilon_t \end{aligned} \tag{2.7}$$

where Employment$_t$ is the log of employment, ExrateV$_t$ is the real exchange rate volatility, RER$_t$ is the log of the real exchange rate, Output$_t$ is the log of manufacturing gross value added, Wages$_t$ is the log of real manufacturing wages, Interestr$_t$ is the long term interest rate, α_0 is the intercept, D$_i$ are the dummy variables for 2008/2009 global financial crisis and labour legislation, T is the trend and ε_t is the error term assumed to be serially uncorrelated. Section 2.4 properly defines these variables.

To find the unique cointegration vector in the ARDL model, the bounds test is implemented as follows: First, I estimate an unrestricted error correction model (ECM) in equation (2.8) below where the lag length (p) is such that the error term is not serially correlated

$$
\begin{aligned}
\Delta Employment_t &= \alpha_0 + \alpha_1 T_t + \varphi_0 Employment_{t-1} + \varphi_1 ExrateV_{t-1} + \varphi_2 RER_{t-1} \quad (2.8)\\
&+\varphi_3 Output_{t-1} + \varphi_4 Wages_{t-1} + \varphi_5 Interestr_{t-1}\\
&+\sum_{i=1}^{p} \phi_i \Delta Employment_{t-i} + \sum_{i=0}^{p} \beta_{1i} \Delta ExrateV_{t-i} +\\
&\sum_{i=0}^{p} \beta_{2i} \Delta RER_{t-i} + \sum_{i=0}^{p} \beta_{3i} \Delta Output_{t-i} + \sum_{i=0}^{p} \beta_{4i} \Delta Wages_{t-i} +\\
&\sum_{i=0}^{p} \beta_{5i} \Delta Interestr_{t-i} + \varepsilon_t
\end{aligned}
$$

where $\varphi' s$ are long run multipliers, ϕ and $\beta' s$ are short run dynamic coefficients.

The second step involves calculating the F statistic (F_{calc}) to test H_0:$\varphi_0 = \varphi_1 = \varphi_2 = ... = \varphi_5 = 0$ against the alternative that at least one $\varphi_i \neq 0$.The test statistic is the standard F statistic with asymptotic distribution that is non-standard under the null hypothesis that there exist no long run relationship between the levels of the included variables. The critical values are provided in Pesaran et al.(2001). The critical values have a lower bound (F_L) assuming that all the regressors are I(0) and an upper bound (F_U) assuming that all the regressors are I(1). If $F_{calc} < F_L$, one cannot reject H_0:$\varphi_0 = \varphi_1 = \varphi_2 = ... = \varphi_5 = 0$.This implies no cointegration exists. If $F_{calc} > F_U$, one has to reject H_0:$\varphi_0 = \varphi_1 = \varphi_2 = ... = \varphi_5 = 0$, implying that a cointegration relation exists. However, when $F_L < F_{calc} < F_U$, the test is inconclusive and the order of integration of the underlying variables has to be investigated to proceed further.

In the third step, the ECM in equation (8) is repeated several times with each of ExrateV, RER, Output, Wages, Interestr as the dependent variable and testing for the joint significance of the lagged level coefficients as in the second step. The number of significant F statistics indicates the number of cointegrating vectors. To proceed with estimating the ARDL model given in equation (7), I require that only one F statistic be significant.

2.6.1 Cointegration data tests

To estimate empirical models using time series data requires that the variables are stationary, implying unit root tests should be done before carrying out any analysis. This is not necessary however in ARDL cointegration model because such a model tests for the long run relationship among variables even if the varaibles are I(0) only, I(1) only or a mixture of the two{ I(0)/ I(1)} i.e without knowing the order of integration of the variables. But

when carrying out the bounds test procedure of Pesaran et al. (2001), some variables might fall in between the lower bound and upper bound which eventually necessitates the need to know the integration order of such variable(s) prior to proceeding further. As a result, it is sufficient to conduct the unit root tests. I apply the Augmented Dickey-Fuller (ADF) and Phillips-Perron(PP) tests to find the order of integration of the variables. Table A.2 and A.3 show these results. Based on these tests, all the variables except the interest rate are I(1). The ADF says that the interest rate might be an I(0) variable while the PP states that it is an I(1). The uncertainty of the interest rate variable justifies the adoption of the ARDL cointegration approach.

<Insert Table A.2 and A.3 Here>

Next I estimate the bounds test for cointegration. These results are shown in table A.4. Table A.4 indicates that there is one cointegrating vector significant at 1% level.

<Insert Table A.4 Here>

2.7 Results

Following the bounds test for cointegration which indicates that there is a unique cointegration vector in the model, I proceed to estimate the ARDL cointegration model given in equation (2.7). In estimating equation (2.7), the most appropriate lag specification is needed. This paper uses the Akaike Information Criterion (AIC) to establish the appropriate lag specification. I set the maximum lag order at four to estimate $(m+1)^{k+1}$ (where m=maximum lag and k=number of regressors) different ARDL models. The choice of 4 lags is because it is consistent with most estimations using quarterly data. Another important factor when estimating ARDL models is that the residuals should not suffer from serial correlation. Two methods can either be used to check for serial correlation namely: the LM test or the F-version which is also known as LMF test. Kiviet (1986) shows that the LMF test performs better in small samples than LM test. As a result, this paper reports the LMF test when doing the diagnostic tests.

In estimating the model, two different ARDL models are estimated. Model one uses the rand/US dollar currency to calculate the volatility as well as the level exchange rate and the ARDL (1,0,2,4,2,4) is selected as showing the appropriate lag specification. Model two uses the real effective exchange rate and the ARDL (1,0,2,4,1,4) is selected as showing the appropriate lag specification. This means that the set of explanatory variables include one lagged value of the dependent variable; a contemporaneous value of the volatility variable; a contemporaneous and two lagged values for the real exchange rate level variable ; a contemporaneous and four lagged values for output; a contemporaneous and two lagged

values for the wages' variable; and a contemporaneous and four lagged values for interest rate for model 2. Table A.7 indicates that there is no serial correlation and heteroscedasticity, and that the functional form is correct.

Table A.5 shows the long run coefficients. Given that the variables are in levels, the long run relationship for volatility is difficult to quantify or attach a meaning even though it has the expected sign and significant in both models. With this in mind, the more important results are found in the ECM specification (see table 8) for it shows the variables as growth rates. The economic significance of the findings, holding other control variables at their sample means suggests that for a one standard deviation increase in real exchange rate volatility for model 1(that is 0.7121) reduces employment growth by about 0.98%[13] and by about 0.87% using model 2. The negative effect exerted by real exchange rate volatility on employment growth found in this paper is similar to other studies that used other methodologies e.g. Demir (2010) using firm level manufacturing panel, others using cross-country panel (see e.g. Belke & Setzer 2003, Belke & Kaas 2004, Belke, Kaas & Setzer 2004) and others using VAR in first difference (see e.g. Gros 1996, Belke & Gros 1998, Belke & Gros 2002). These results confirms that the real exchange rate volatility played a part for the negative developments in the South African labour markets following the question posed in the introduction section.

<Insert Table A.5, A.6 and A.7 Here>

The paper is using the direct quotation for the RER(meaning an increase is a depreciation) for model 1 and indirect quotation for model 2 (meaning an increase is an appreciation).The results show that in the long run it is insignificant for both models. However, in the short run it indicates that a depreciation of the currency will lead to a reduction in employment growth as shown by model 1 at 10% level. This result is contrary to what I expected because the depreciation of the domestic currency should lead to an increase in domestic demand. This in turn should signal to domestic producers to produce more and thus as output increases there is a potential to increase employment to help in the production of more output. However, the issue of depreciation is not enough to result in more exports due to more demand because the literature on growth tells us that only when there is real depreciation plus undervaluation of the same currency then growth will come. This follows some researchers, for example, Saayman (2007) who asserts that the Rand was possibly overvalued in most parts between 1995 and 2005.On the other hand, this result might mean that the manufacturing sector uses more capital and less labour.

Output has the expected positive and significant effect in the long run for both models with biggest magnitude as compared to other variables. However, in the short run mixed results are found. Manufacturing wages have the negative effect in the short run using model 1. The negative effects of wages on employment growth questions the behaviour of trade unions

[13] Employment effect of volatility= one standard deviation increase in volatility(0.7121)*beta(-0.0137)*100.

that advocate an increase in wages of their members at the same time wanting employment to increase. This follows the notion that an increase in wages results in an increase in the prodcution costs which are likely to cause some workers losing their jobs. However, both models indicate insignificant effects in the long run for the wage variable. The Interest rate variable has the expected negative effect in the long run using model 2.Given that South African Reserve Bank follows the inflation targeting regime, the negative impact of interest rate on employment is due to the result of the central bank increasing the interest rate in the effort of controlling inflation though this is proving not to be helpful in limiting unemployment rate. Thus the results for interest rates poses some challenge to monetary policymakers given that there is some tradeoff that has to be made between controlling inflation and increasing growth.

The dummy variable for the 2008/2009 global financial crisis is significant and negative for model 2 which indicates that the financial crisis reduced employment growth. The labour legislation dummies are insignificant. Table A.6 shows that the error correction term {ECM(-1)} is significant and has the expected/ correct negative signs for both models i.e. -0.6272 for model 1 and -0.6342 for model two. The correct sign for the ECM(-1) result confirms the existence of long run relationship and indicates that the speed of adjustment from short run dynamics to the long run equilibrium is relatively quick.

2.8 Conclusion

South Africa's unemployment rate has persistently remained high and this has left concerns to the policymakers. This paper empirically examines the impact of real exchange rate volatility on employment growth in the manufacturing sector, making a contribution to how real exchange rate volatility can be made responsible for the negative developments in the South African labour market. The ARDL cointegration method is used to analyse this impact given its nice property of providing consistent estimates in small sample size as done in this study. The findings suggests that real exchange rate volatility has a negative impact on the South African labour market.

The contractionary effect of exchange rate volatility on employment is consistent with other studies. The results also show that depreciation of the RER decreases employment growth in the short run. Manufacturing output, manufacturing wages as well as long term interest rates are also found to have a significant effect on manufacturing employment. Manufacturing output is found to have the biggest magnitude compared to other variables. This suggests that macroeconomic policies that enhance output should be implemented. The results also suggest that the government can reduce the negative effects on manufacturing employment by adopting measures that minimise real exchange rate volatility.

Chapter 3

The Determinants of Exchange Rate Volatility in South Africa

3.1 Introduction

Increasing financial liberalisation since the collapse of the Bretton Woods system in the 1970s has rendered the exchange rates to be volatile both in developed and developing countries. As a result, the effects and causes of exchange rate volatility have become of particular interest to both researchers and policymakers. South Africa liberalised its capital account in March 1995 following the abolishment of the dual exchange rate system which had been in place since mid-1980s. Due to this, the South African currency (the rand) has subsequently been more volatile than before (Arezki et al. 2014, Ricci 2005). According to the 2013 survey by the Bank for International Settlements (BIS) (see table B.1), the rand is one of the most important emerging market currencies.

< Insert table B.1 here>

In empirical studies, some researchers find that economic openness reduces exchange rate volatility (Hau 2002, Calderón 2004, Bleaney 2008) whilst others find the opposite or no relationship (Amor & Sarkar 2008, Caporale et al. 2009, Grydaki & Fountas 2010, Chipili 2012, Jabeen & Khan 2014). Due to conflicting results in the empirical studies, only an empirical analysis can show the relationship between exchange rate volatility and openness in a country which has experienced an institutional change in their exchange rate regime. As such, this paper follows the modified version of the New Open Macroeconomic Model of Obstfeld & Rogoff (1996) by Hau (2002). This theoretical model asserts that there should be a negative relationship between exchange rate volatility and economic openness. That is, more open economies should have less exchange rate volatility. As such, this study tests the

hypothesis, did economic openness in March 1995 decrease exchange rate volatility in South Africa?

Few studies investigate the determinants of rand volatility. Arezki et al. (2014) examines the relationship between rand volatility and gold price volatility. Farrell (2001) analyses whether the imposition of capital controls in mid-1980s affected the commercial rand variability differently to financial rand variability between 1985 and 1995. This paper contributes to the literature by finding the sources of rand volatility using output volatility, money supply volatility, foreign reserves volatility, commodity price volatility, openness and dummy for capital account liberalisation as explanatory variables.

Several factors motivate this study. Firstly, many variables influence the level of the rand(Aron et al. 1997, MacDonald & Ricci 2004, Frankel 2007, Saayman 2007, Faulkner & Makrelov 2008). As such, many variables might also cause large swings in the exchange rates. Secondly, exchange rate volatility is important in macroeconomics literature. In South Africa there is evidence of exchange rate volatility having significant effects on macroeconomic factors such as employment and trade(Todani & Munyama 2005, Mpofu 2013, Aye et al. 2014). Finding the sources of exchange rate volatility is relevant to policymakers and researchers on how to tackle some of the effects of exchange rate volatility.

Thirdly, studies by Hau (2002) and Calderón (2004) attempted to find the sources of exchange rate volatility in South Africa[1]. However, these studies use cross-country data and find aggregate results which do not isolate country specific effects. Besides Hau (2002) states that the theoretical linkage between openness and real exchange rate volatility depends on the magnitude of the monetary and real shocks of each country. This suggests that analysing the sources of exchange rate volatility at a country level will likely be better for formulation of the correct type of policy response. Furthermore, they measure exchange rate volatility using very low frequency data(i.e yearly data) yet exchange rate volatility will be best measured using either very high frequency data (i.e intraday or daily data) or low frequency data (i.e monthly or quarterly data).

Fourthly, South Africa's currency is on average relatively more volatile compared to India, South Korea and Russia's currencies for the period 1992 — 2013[2]. On the other hand, South Africa's currency on average is less volatile compared to Turkey, Brazil and Malaysia's currencies. This is based on using simple standard deviations of log real exchange rate of the domestic currency per United States dollar as shown in table B.2.

<Insert table B.2 here>

[1] This follows the fact that South Africa is included in their sample of countries analysed.

[2] This shorter period is chosen due to lack of data for some variables used when calculating the real exchange rate prior to 1992M7. Here Real Exchange Rate is calculated as Nominal exchange rate * $\frac{CPI^*}{CPI}$.where CPI^* is the foreign price and CPI is domestic price.

Using GARCH models for the period 1986 to 2013 employing monthly data, the study finds that switching to a floating exchange rate regime increases exchange rate volatility, openness reduces exchange rate volatility using bilateral exchange rate of rand/US dollar while using effective exchange rate, the results suggest that trade openness for South Africa with some of its trading partners is less open. The results also show that output, commodity prices, money supply and foreign reserves volatilities significantly influences exchange rate volatility.

The structure of the paper is as follows: section 2 presents the literature review. Section 3 presents the theoretical model of exchange rate volatility. Section 4 reports the data used and the descriptive statistics of the data used. Section 5 presents the econometric approach used while section 6 reports empirical results. Section 7 provides conclusion.

3.2 Literature Review

There is no general consensus on the macroeconomic determinants of exchange rate volatility in the literature. This is due to different approaches used based on different theoretical models of exchange rate level determination. Some studies find the sources of exchange rate volatility based on a specific exchange rate level model whilst others are based on a synthesis of exchange rate level models.

Examples of specific models are as follows. First are studies based on the monetary models of exchange rate level determination (Morana 2009, Grydaki & Fountas 2009, Grydaki & Fountas 2010). These studies emphasise on monetary variables as the determinants of exchange rate volatility. Second is the Optimum Currency Areas (Bayoumi & Eichengreen 1998, Devereux & Lane 2003). These studies put emphasis on trade linkages; asymmetric or similarity of economic shocks to output, country size and geographic factors as the determinants of exchange rate volatility. Third is the New Open Economy Macroeconomics (Hau 2002, Calderón 2004, Amor & Sarkar 2008, Caporale et al. 2009). These studies stress that monetary variables and non-monetary factors are important in explaining exchange rate volatility.

The papers based on a synthesis of exchange rate models include Chipili (2012) and Jabeen & Khan (2014) to mention a few. These studies just use variables from different specific models they deem important in explaining exchange rate movements in the countries of their studies. However, other studies find no link between macroeconomic fundamentals and exchange rate volatility(Flood & Rose 1995). Such studies support the role of non-macroeconomic determinants of exchange rate volatility. For example, the microstructure factors like the aggregation of a large number of news information arrival process (Morana 2009 who cites Andersen & Bollerslev 1997).

Given the different emphasis of the determinants of exchange rate volatility above, this study will use the New Open Economy Macroeconomics model. This is due to the opening of the financial system in South Africa to the rest of the world in March 1995. Prior to March 1995, South Africa had followed the dual exchange rate system from September 1985 to March 1995. During this period, the foreign exchange transactions of non-resident portfolio investors on the capital account was separate from all other foreign exchange transactions[3]. This was as the result of the increased volatility in the South African rand during the period 1982 to 1985 due to political pressure from the international community which imposed trade sactions because of apartheid. As such, the unification of the financial and commercial rand systems of capital controls in March 1995, make the use of New Open Economy Macroeconomics model appropriate to investigate the impact of such a change in institutional settings on the relationship between exchange rate volatility and its fundamentals. Subsequent empirical literature finds the following:

Arezki et al. (2014) employ a Vector Error Correction Model (VECM) to examine the relationship between South African rand and the gold price volatility for the period 1980 — 2010 using monthly data. Their result indicate that gold price volatility is vital in explaining the excessive exchange rate volatility of the rand. However, their paper only uses the commodity price which do not capture a larger set of fundamental relative price movements. As such this paper contributes to this literature by using more explanatory variables for the determinants of South African rand volatility. In addition, this paper contributes to the debate about exchange rate in South Africa by focusing on the determinants of exchange rate volatility (i.e. the second moment of the relationship between the exchange rate and its determinants) given that most studies in South Africa have analysed the determinants of the level of the exchange rate (i.e. the first moment of the relationship between the exchange rate and its determinants). That is, estimating the real equilibrium exchange rate level and the extent of its misalignment (Aron et al. 1997, MacDonald & Ricci 2004, Frankel 2007, Saayman 2007, Faulkner & Makrelov 2008).

Hau (2002) employs cross-sectional analysis on forty eight countries over the period 1980 - 1998. He uses annual data on real effective exchange rate (REER) volatility measured as the moving sample standard deviation of REER percentage changes over three-year period. With control variables of per capita GDP, dummies for revolutions and coups, central bank independence and exchange rate commitments, Hau finds a negative relationship between real exchange rate volatility and trade openness. That is, more open economies will have less real exchange rate volatility. Following the theoretical linkage between real exchange rate volatility and openness that this relationship depends on the magnitude of monetary and real shocks of each country, Hau re-estimates the regression equation using only 23 OECD

[3]The financial rand system of capital controls was imposed on non-resident portfolio investors while the other was the commercial rand system.

countries given that they are more homogeneous. He still finds the negative relationship between real exchange rate volatility and trade openness but the results are more pronounced (they have higher explanatory power) than the results using 48 countries.

Calderón (2004) uses a GMM method on 77 industrial and developing countries over the period 1974 - 2003. Calderon uses annual data on REER volatility measured as standard deviation of changes in the REER over a 5-year period as well as the volatility of real exchange rate fundamentals. Calderón (2004) finds that there is a negative relationship between real exchange rate volatility and economic openness. He also finds a negative relationship between real exchange rate volatility and government spending volatility but finds a positive relationship between real exchange rate volatility and output, money supply and terms of trade volatilities respectively. Using the same GMM method, Amor & Sarkar (2008) also find a negative relationship between exchange rate volatility and trade openness for 10 South and South East Asia economies. Bleaney (2008) also finds similar results between real exchange rate volatility and trade openness.

Caporale et al. (2009) find similar negative relationship between real exchange rate volatility and trade openness for the period 1979 - 2004. Their results show that there is a positive relationship between real exchange rate volatility and financial openness for the entire sample which comprises of 39 developing countries (20 from Latin America, 10 from Asia and 9 from MENA[4]). These results are similar to Amor & Sarkar (2008). However, the regressions for the three separate regions find different results. For Asian region, they find that financial openness causes real exchange rate to be more volatile but REER volatility is mainly due to domestic real shocks while external shocks contribute a small role. For MENA region, they find that financial openness causes real exchange rate to be less volatile but REER volatility is mainly caused by monetary and real shocks. As for Latin American region, they find that external and monetary shocks are the main sources of real exchange rate volatility. The results by Hau(2002) for 23 OECD countries and the analysis by Caporale et al.(2009) suggests that finding the sources of exchange rate volatility for a single country is more appropriate for policy makers cause the results are not generalised. This study also improves on the studies that use standard deviation as the proxy for volatility because GARCH models are able to describe the time-varying volatility directly unlike the standard deviation models.

Using daily data from 1 January 1999 to 31 December 2004, (Stancık 2006, Stancık 2007) investigates the determinants of real exchange rate volatility for six Central and Eastern European countries. The study focuses on trade openness, news factor and exchange rate regime as explanatory variables. Real exchange rate used is the bilateral between the Euro

[4]The countries in the MENA region include: Algeria, Egypt, Iran, Israel, Jordan, Morocco, Syria, Tunisia and Turkey.

and the U.S. dollar. Real exchange rate volatility is measured using the threshold autoregressive conditional heteroskedasticity (TARCH) model. The final model is estimated using Ordinary Least Squares (OLS) and the results for each country indicate that there is a negative relationship between real exchange rate volatility and trade openness for the four countries. The other two countries show insignificant coefficients between real exchange rate volatility and trade openness. The news factor depicts mixed results for different countries.

Chipili (2012) examines the sources of volatility of Zambian kwacha exchange rate (real and nominal) using the GARCH models (GARCH, TARCH and EGARCH). He finds that both monetary factors (money supply, inflation, short term domestic interest rate and foreign reserves) and real factors (terms of trade, openness and output) affect exchange rate volatility. The results indicate that real factors have smaller effects on exchange rate volatility than monetary factors. This suggest that monetary policy has an important role in mitigating the volatility of the exchange rate. His results show that using the GARCH(1,1) and TARCH(1,1) models, the relationship between exchange rate volatility and openness is insignificant. Using EGARCH model, he finds positive and significant relationship between exchange rate volatility and openness for kwacha and other 19 currencies except for kwacha/Zim dollar which is negative and significant. He asserts that the positive and insignificance of openness for some exchange rate volatility suggest that the degree of openness, that is, the extent of trade linkages between Zambia and her trading partners is low relative to what is implied by theory.

Jabeen & Khan (2014) also use various macroeconomic factors to find the determinants of exchange rate volatility in Pakistan using GARCH(1,1) and TARCH(1,1) models. Their study finds that real output volatility, foreign exchange reserves volatility, inflation volatility, productivity and terms of trade volatility are important determinants of exchange rate volatility. Their study uses trade restrictions measured by the reciprocal of trade openness and the results find positive and insignifcant coefficients for this variable. Morana (2009) also finds support for macroeconomic fundamentals in influencing exchange rate volatility. Morana (2009) argues that the exchange rate is an important determinant of aggregate demand and as such conducts the Granger-Causality test to establish the direction of causality. The results show that the direction of causality is bi-directional but it is stronger from macroeconomic factors to exchange rate volatility than vice-versa. Hence, this suggest that stability in the macroeconomic variables is recommended to reduce exchange rate volatility which is contrary to the finding by Flood & Rose (1995) in their study for G-7 countries.

3.3 Theoretical Model

The theoretical foundation linking exchange rate volatility, economic openness and the volatility of real exchange rate fundamentals is the New Open-Economy Macroeconomics model. The New Open-Economy Macroeconomics model is based on the work of Obstfeld & Rogoff (1996) on page 689 which formalises exchange rate determination in the context of dynamic general equilibrium models with explicit microfoundation, imperfect competition and nominal rigidities. To show this linkage, this study follows the work of Obstfeld & Rogoff (1996) and Hau (2002)[5].

Using the first order conditions derived from the basic set up of the model, trade openness is defined as:

$$Openness = \frac{P_T C_T}{P_N C_N + P_T C_T} = \gamma \tag{3.1}$$

Following this definition, the dynamics of the model are analysed taking the log-linear approximation from the initial steady state. The short run percentage deviations from the initial steady state is denoted by $X = \frac{(X_1 - \overline{X_0})}{\overline{X_0}}$ while the long run percentage deviations from the initial steady state is denoted by $\overline{X} = \frac{(\overline{X} - \overline{X_0})}{\overline{X_0}}$.

Given the above, the model first analyses monetary shocks. The model assumes that the economy encounters an unanticipated permanent monetary shocks, that is, $M^S = \overline{M^S}$. With this assumption and log-linearizing equation B.13 around the steady state results in the following equation:

$$\varepsilon (m - p) = p_T - p + \frac{\beta}{1 - \beta} (p_T - p) \tag{3.2}$$

Given that the prices of nontradables are fixed in the short run, that is, $P_N = 0$ and the long run neutrality of money, $\overline{P_T} = \overline{M^S}$ leads to:

$$P_T = \frac{\beta + (1 - \beta)\varepsilon}{\beta + (1 - \beta)(1 - \gamma + \gamma\varepsilon)} \overline{M^S} \tag{3.3}$$

Since the law of one price holds for tradables, then the short run percentage price change is proportional to money supply and exchange rate. That is, $P_T = M^S = E$. Given that consumption smoothing implies a constant consumption of tradables, it then means $C_T = 0$. Following this and the nominal rigid nontradables prices implies that the real price of nontradables decreases and their demand increases. Hence log linearising equation B.11 depicts that consumption expansion in nontradables is proportional to the tradable price

[5] See the appendix for the detailed explanation of the basic set up and steady state analysis of the model.

increase. That is, $C_N = P_T$. So using equation 3.1, Hau (2002) shows that the percentage real exchange rate change is given by:

$$E - P = P_T - P = (1 - \gamma) P_T = (1 - Openness) M^S \tag{3.4}$$

Thus

$$Vol = \left[\varepsilon (E - P)^2\right]^{\frac{1}{2}} = (1 - Openness) \sigma_M^2 \tag{3.5}$$

Meaning more open economies are expected to have less real exchange rate volatility holding all other things constant. This is the hypothesis to be tested in this paper as already mentioned in section one. Second, the model analyses real shocks. The model assumes the nontraded sector faces an unanticipated permanent increase in marginal disutility and log linearising equation B.12 gives the following equation:

$$-P_T - C_T = \kappa + y_N \tag{3.6}$$

Given that the model assumes constant endowment of tradables, $\overline{y_T}$, constant net foreign assets and the consumption-smoothing motive, means that $C_T = 0$. If equation B.11 is log linearised, we get $C_T = P_T$ given rigid nontradable prices ($P_N = 0$). Market clearing conditions for nontradables, $C_N = y_N$, then determines the fluctuations in the prices of tradables to get, $P_T = \frac{1}{2}\kappa$. Since the price of tradables are linked to the world price level, the volatility of real exchange rate is given by:

$$E - P = P_T - P = (1 - \gamma) P_T = (1 - Openness) \frac{1}{2}\kappa \tag{3.7}$$

Thus

$$Vol = (1 - Openness)\sigma_\kappa^2 \tag{3.8}$$

Meaning an unanticipated real shocks also generates the negative relationship between economic openness and real exchange rate volatility as monetary shocks. Lastly the model analyses fiscal shocks and assumes the economy faces an unanticipated permanent fiscal shocks. Using this information and log linearising equation B.16 as well as using other equations from the model leads to the following relationship between real exchange rate volatility and government spending:

$$Vol = (1 - Openness)\sigma_G^2 \tag{3.9}$$

Hence, controlling for various explanatory variables, the model states that there should be

a negative relationship between exchange rate volatility and economic openness. The next section defines all the variables used in this paper.

3.4 Data

This paper uses monthly time series data for South Africa from 1986M2 — 2013M11 obtained from South African Reserve Bank (SARB), Datastream and IMF. All indices used have the base year of 2010. All the variables are seasonally adjusted using TRAMO/SEATS[6] ARIMA tools. This is done to remove cyclical seasonal movements that are common in time series observed at monthly and quarterly frequency. The variables are defined as follows:

The dependent variable is the real exchange rate volatility measured using the conditional variance from a GARCH(1,1) process based on the following equation:

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \varepsilon_t$$

$$h_t^2 = \lambda_0 + \lambda_1 \varepsilon_{t-1}^2 + \lambda_2 h_{t-1}^2 \tag{3.10}$$

where x_t=dlog(real exchange rate) and h_t^2 = conditional variance of ε_t. The real exchange rate is calculated as follows:

$$RER = E * \frac{P^*}{P} \tag{3.11}$$

where RER refers to real exchange rate, E refers to nominal exchange rate using South African rands per United States dollar, P* refers to foreign price index and P refers to domestic price index. Which price indices to use remain a practical problem. The literature suggests the use of consumer price index (CPI), wholesale price index / producer price index, GDP deflators and unit labour costs. Due to data availability, two different measures of the real exchange rate are applied in this study. One based on consumer prices (equation 28 below) and, the second on the relative prices of tradables and non-tradables (equation 29 below) as follows:

$$RERCPI = E * \frac{CPI^*}{CPI} \tag{3.12}$$

$$RERWPI = E * \frac{P_T^*}{P_N} = E * \frac{WPI^*}{CPI} \tag{3.13}$$

In addition to bilateral RER, multilateral RER is also used. Real Effective Exchange Rate (REER) refers to the trade weighted real exchange rate. This is based on the 20 trading

[6]TRAMO stands for Time Series Regression with ARIMA noise, missing values and outliers. SEATS stands for Signal Extration in ARIMA Time Series.

partners of South Africa based on manufacturing goods. Both bilateral and multilateral nominal exchange rates are also used. Nominal Exchange Rate (RUSNOM) refers to the nominal exchange rate for the rand per US dollar. Nominal Effective Exchange rate (NEER) refers to the trade weighted nominal exchange rate for the 20 trading partners of South Africa.

Independent variables include: *Output* which is measured using real GDP. This variable is used to proxy real productivity shock. However, RGDP is not available in monthly frequency. As a result, monthly RGDP is interpolated using the cubic spline method from quarterly RGDP. *Money Supply.* The narrow definition of money supply is used, that is, M1. *Openness.* Trade openness *(to)* is measured as the ratio of exports of goods and services and imports of goods and services to nominal GDP. The values of the three variables are all expressed in domestic currency. However, due to the non-existence of monthly GDP data, monthly GDP data is interpolated from quarterly nominal series using the cubic spline method. The cubic spline method is common in the literature for converting either annual or quarterly GDP data to monthly data(Chipili 2012)[7].

Foreign Reserves. Gross reserves are used. This variable is used via economic openness given that through openness, central banks are able to accumulate foreign reserves. *Commodity Prices.* Real gold price in domestic currency based on the pricing in London is used to proxy commodity prices. This study uses commodity prices volatility as one of the determinants of exchange rate volatility unlike other studies that have used the Terms of Trade (TOT) volatility. This follows the argument and findings by other researchers (Cashin, Cespedes & Sahay 2002, MacDonald & Ricci 2004, Frankel 2007) that TOT tends not to be significant in most countries that are commodity exporters as one of the determinant of exchange rate whilst commodity prices tend to be significant. MacDonald & Ricci (2004) assert that this is due to two reasons. First, commodity prices are relatively more accurate in terms of measurements unlike TOT which are based on arbitrary construction of country-specific export and import deflators. Second, commodity price data are frequently made available.

Using real gold price volatility as an independent variable might cause one to argue that there is reverse causality (i.e. endogeneity problem). For example, Arezki et al. (2014) find that between 1979 and 1995 causality runs from Rand volatility to Gold price volatility, but between 1995 and 2010, causality runs from gold price volatility to Rand volatility. Accordingly, I run Granger causality tests between Rand volatility and goldprice volatility. The results indicate that for the study period for this paper, causality runs from gold price volatility to Rand volatility only[8]. That is, it is only gold price volatility causing Rand

[7]Chipili (2012) converts annual to monthly while Schneider et al.(2007), "Yemen: Exchange Rate Policy in the Face of Dwindling Oil Exports" International Monetary Fund Working Paper No.0705, converts to quarterly.

[8]The table reported in the appendix shows that one lag is used. However, I also tried using lags from 2 up to 12 given that its monthly data. The results are still the same that causality runs from gold price volatility to Rand volatility only.

volatility. Hence there is no issue of possible reverse causality. *Exchange Rate Regime.* Exchange rate regime is represented by a dummy variable. The dummy for this variable takes the value of 1 from 1995M4 onwards and 0 otherwise. Following the definition of the variables to be used in section five when I do the econometric analysis, first I present the preliminary tests for the variables which is what I do in the next section.

<Insert tableB.11 here>

3.4.1 Descriptive Statistics

Estimating empirical models using time series data requires that the variables are stationary, implying unit root tests should be done before carrying out any analysis. Accordingly, I apply the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to find the order of integration of the variables. Table B.3 shows that all the variables are integrated of order one {I(1)} while table B.4 indicates that all the variables but trade openness are integrated of order 1 {I(1)}.

<Insert Table B.3 and B.4 Here>

After finding the stationarity properties of all the variables, I then find the summary statistics of all the stationary variables to show some key stylised facts. Table B.5 indicates that the variables exhibit similarities with the behaviour of financial time series. That is, having excess kurtosis and the variables not following a normal distribution. For example, 8 out of 10 variables indicate excess kurtosis. The kurtosis of the standard normal distribution is 3. The skewness of the variables is not equal to zero which implies the variables do not follow a standard normal distribution. Using the Jarque-Bera statistic, table B.5 shows that 9 out of 10 variables are not normally distributed given that they have significant coefficients. Furthermore, table B.5 shows that money supply and output varied less than the exchange rate (using the bilateral rand/US dollar and nominal effective exchange rate) based on the standard deviation measure of variability. This is similar to the findings by Flood & Rose (1995), Hviding, Nowak & Ricci (2004) and Chipili (2012).

<Insert Table B.5 Here>

Having removed the unit root from the variables, I examine if all the variables with the exception of trade openness have volatility clustering, that is, the presence of ARCH effects — meaning there is heteroskedasticity in these variables. Accordingly, I apply the ARCH Lagrange Multiplier (ARCH-LM) test and the White (1980) test in cases that ARCH-LM is not adequate to detect heteroskedasticity. The estimated mean equation for each variable includes a constant and the lags of the corresponding variable only. Table B.6 indicates the presence of volatility clustering in all 9 variables with significance at 1% level for output,

gold price, money supply, real and nominal effective exchange rate and 5% level for real and nominal bilateral exchange rate for rand/US dollar while foreign reserves are significant at 10%. Having volatility clustering implies that it is appropriate to use GARCH models. Figures B.1 to B.5 show the estimated conditional variance for the exchange rates and confirms that there is volatility clustering. That is, large changes tend to be followed by large changes and small changes tend to be followed by small changes, and periods of tranquility interchange with periods of high volatility.

<Insert Table B.6 and Figures B.1– B.5 Here>

Table B.7 shows the correlation matrix for exchange rates volatility, economic openness and volatility of exchange rate fundamentals. The table indicates that there is negative correlation between exchange rates volatility and trade openness. The negative correlation between exchange rates volatility and trade openness implies that the higher the degree of trade openness in goods and services, the lower the volatility of exchange rates. This is a preliminary confirmation of the hypothesis mentioned in section 1 and what theory mentions as asserted in section three.

<Insert Table B.7 Here>

3.5 Econometric Approach

The empirical literature mostly proxies volatility of the variable(s) in question by either conditional variance or standard deviation models. Standard deviation method includes both predictable and unpredictable components of volatility whilst the conditional variance method is a better proxy for uncertainty because it contains unpredictable component of volatility. Conditional variance models include ARCH-type, stochastic volatility and implied volatility. This study focuses on ARCH-type models following their introduction by Engle (1982) and their extension by Bollerslev (1986).

The behaviour of the exchange rates exhibits volatility clustering whereby large changes tend to be followed by large changes, and small changes by small changes alike and periods of tranquility interchange with periods of high volatility making successive exchange rate changes dependent on each other (Kwek & Koay 2006, Chipili 2012). The empirical literature confirms that exchange rates like other financial time series show non-linear behaviour (Chipili 2012). Such behaviour can be estimated using GARCH models given that they (GARCH models) are able to model and forecast time-varying variance.

As such, this study utilises a GARCH(1,1) and EGARCH(1,1) models to study the sources of exchange rate volatility in South Africa. A GARCH(1,1) model is adopted following the

literature which show that such a model is parsimonious even though higher order models do exist. The estimated empirical equations are:

Mean equation for exchange rate volatility

$$\begin{aligned}\Delta x_t &= \lambda_0 + \sum_{i=1}^{q} \lambda_i \Delta x_{t-1} + \phi_1 \Delta Output_t + \phi_2 \Delta MS1_t + \phi_3 \Delta Open_t \\ &\quad + \phi_4 \Delta Fxres_t + \phi_5 \Delta Rgoldp_t + \phi_6 Exrate \operatorname{Re} gime_t + \varepsilon_t\end{aligned} \tag{3.14}$$

Variance equation for exchange rate volatility using a GARCH(1,1) method

$$\begin{aligned}h_t^2 &= \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta h_{t-1}^2 + \varphi Exrate \operatorname{Re} gime_t + \zeta_1 \Delta Output_t + \\ &\quad \zeta_2 \Delta MS1_t + \zeta_3 \Delta Open_t + \zeta_4 \Delta Fxres_t + \zeta_5 \Delta Rgoldp_t + v_t\end{aligned} \tag{3.15}$$

Variance equation for exchange rate volatility using an EGARCH(1,1) method

$$\begin{aligned}\ln(h_t^2) &= \alpha_0 + \alpha_1(\varepsilon_{t-1}/h_{t-1}^{0.5}) + \lambda_1(\varepsilon_{t-1}/h_{t-1}^{0.5}) + \beta \ln(h_{t-1}^2) + \\ &\quad \varphi Exrate \operatorname{Re} gime_t + \zeta_1 \Delta Output_t + \zeta_2 \Delta MS1_t + \\ &\quad \zeta_3 \Delta Open_t + \zeta_4 \Delta Fxres_t + \zeta_5 \Delta Rgoldp_t + v_t\end{aligned} \tag{3.16}$$

where Δx_t is the logarithmic first difference in the exchange rate; ε_t is residuals that are used to test for the presence of ARCH effects in the exchange rate; q is the lag length; h_t^2 is conditional variance of x_t derived from GARCH(1,1); $\lambda_0, \lambda_i, \phi_{1,...,6}$, $\lambda_1, \alpha_{0,1}, \beta, \varphi$ and $\zeta_1, ..., \zeta_5$ are parameter coefficients to be estimated. Even though the objective of the study is to find macroeconomic factors that drive exchange rate volatility, the explanatory variables are also included in the mean equation. This is done because exchange rate volatility is uncertain and as such the impact of exchange rate level should be controlled for or found first. This is also because at monthly frequency, fundamentals matter for exchange rate movements unlike as done by Fidrmuc & Horváth (2008) who do not include explanatory variables in the mean equation (they only include lagged values of the exchange rate) due to the fact that at daily frequency, fundamentals do not matter much in explaining the movements of the exchange rate. An EGARCH model is also estimated because the literature shows that asset prices react differently to bad and good news. Implying it is also appropriate to estimate GARCH models with asymmetry effects. There are two models with asymmetry effects

namely, threshold GARCH(TGARCH) and exponential GARCH(EGARCH). However, this study uses an EGARCH only because according to Enders (2010), this model is advantegeous over the TGARCH. An advantage of EGARCH models is that it does not require restriction of non-negativity of coefficients like in a GARCH model.

3.6 Results

In estimating the GARCH models, various AR(p) model specifications for the mean equation are used together with the variance equation. That is, estimating equations 3.14 and 3.15 for a GARCH(1,1) model and equations 3.14 and 3.16 for an EGARCH model. The best model is chosen based on the diagnostic tests of standardised residuals which show the absence of serial correlation and no remaining ARCH effects. When both GARCH(1,1) and EGARCH(1,1) are significant for a specific exchange rate series, the best model is also based on the model with the larger value of log likelihood and, the smallest values for AIC (Akaike Information Criteria) and SIC (Schwartz Information Criteria). The exchange rate series estimated include, real effective exchange rate (REER), nominal effective exchange rate (NEER), real bilateral exchange rate for the rand/US dollar measured using consumer price indices for both countries (RERCPI) and the one using wholesale price index for the foreign country and consumer price index for the domestic country (RERWPI), and nominal bilateral rand/US dollar (RUSNOM). Accordingly, the Q-statistic for standardised residuals, the Q-statistic for squared standardised residuals and the ARCH-LM in table B.10 indicate that there is no serial autocorrelation and no ARCH effects remaining given the insignificant p-values. The results show that conditional volatility is persistent and mean reverting in all exchange rates given that h_{t-1}^2 coefficient is significant and less than one as shown in tables B.8 and B.9.

<Insert tables B.8, B.9 and B.10 here>

The results for the EGARCH models show that the asymmetric term is insignificant for RERCPI, RERWPI, RUSNOM and NEER series whilst its significant and negative for the REER series at 10% level. This suggests that there is no impact of news effect on the RERCPI, RERWPI, RUSNOM and NEER series at monthly level. This is inline with the efficient market hypotheis which states that the effect of news on asset prices like exchange rate clear fast and is immediately reflected in the changes of the asset price in question. Hence at monthly frequency, the effect of news might have less effect. These results are similar to other studies that do not find significant effects of asymmetric GARCH models at monthly frequency like Jabeen & Khan (2014) and Chipili (2012). The significance of EGARCH using REER suggest that the negative news lead to a higher subsequent increase in exchange rate volatility compared to positive news.

In addition, the results about insignificance of the asymmetric term which captures the impact of news, suggests that the behaviour of exchange rate should also be analysed using short-term periods, for example, daily or intraday data. This follows some researchers (see e.g. Flood & Taylor 1996, MacDonald 1999, Morana 2009) who argue that exchange rate movements cannot always be explained by flow demand and supply components but by using market microstructure models too.

Conditional volatility persists for about a month on average following a shock in REER, NEER and RERCPI based on the half-life (HL) measure. But conditional volatility persists for about six months and twelve months on average following a shock in RUSNOM and RERWPI series respectively. The persistence of past shocks on conditional volatility measured by HL is calculated as $\log(0.5) / \log(h_{t-1}^2)$. HL then captures the period it takes for a shock to volatility to decrease to half its original size and h_{t-1}^2 is the speed of convergence to the steady state level. Furthermore, the results show that REER and RUSNOM are GARCH(1,1) models given the significance of both ε_{t-1}^2 and h_{t-1}^2 terms. However, for RERCPI, RERWPI and NEER series, the results indicate the presence of strong GARCH effects given the significance of h_{t-1}^2 only, a result which is similar to Singh (2002).

Given the study's objective of finding the determinants of exchange rate volatility, only the parameters in the variance equation(s) are analysed. The results show that the exchange rate regime dummy is positive and significant. This means that switching to a floating exchange rate system significantly leads to more exchange rate volatility which is consistent with most findings in the literature (see e.g. Canales-Kriljenko & Habermeier 2004, Stancık 2007, Chipili 2012) and the hypothesis of the rand's behaviour as mentioned in section one by some researchers (see e.g. Arezki et al. 2014, Ricci 2005).

Using the exchange rate series of REER, NEER, RERWPI and RUSNOM, the results show that real gold price volatility has significant and positive effects on the exchange rate volatility. This implies that as gold price volatility increases so does exchange rate volatility. The significance of real gold price volatility in influencing exchange rate volatility is similar to the study by Arezki et al. (2014) who use a different method. The positive effect is similar to studies that use terms of trade variable (see e.g. Calderón 2004, Caporale et al. 2009, Jabeen & Khan 2014).

As for trade openness, the results indicate negative and significant coefficients using the RERWPI and RUSNOM series. This means that as trade openness increases the exchange rate volatility decreases. These results are inline with the theoretical model explained earlier in section three and the results found by other studies (Hau 2002, Calderón 2004, Caporale et al. 2009). However, using REER series, the results are positive and significant which is contrary to what theory says as mentioned earlier in section 3. The positive and significant value suggests that the degree of openness is low relative to what theory says. This implies

that South Africa needs to increase its trading with the 20 countries (or some of them) used in the construction of the REER by South African Reserve Bank. The results may also be affected by the use of aggregate as opposed to bilateral trade data as proposed by OCA theory(Hau 2002).

Foreign reserves have a negative and significant value for NEER. This implies that changes in foreign reserves creates confidence in foreign markets as argued by Hviding et al. (2004). This follows the argument that high and adequate international reserves are important for the prevention of currency crisis given that it signals the ability of the central bank to intervene in the foreign exchange market to stabilise the currency as well as boosting confidence for credit ratings.

As for money supply volatility, the results are negative and significant using the RERCPI series. This result is similar to Morana (2009) who finds a negative value in one country and Grydaki & Fountas (2010) who finds negative money supply for Argentina and Chile. Carrera & Vuletin (2002) assert that the negative effect is associated with increased interest rates which lead to a decrease in money supply and therefore a decline in exchange rate volatility. This suggests that the higher interest rates in South Africa leads to more short term capital inflows with the expection of higher returns and thus increases exchange rate volatility.

Output has a positive and significant effect on RERWPI volatility. This is inline with the perspective of Friedman (1953) that exchange rate volatility might be caused by macroeconomic instability. Meaning as instability increases, exchange rate volatility also increases. The coefficients are insignificant when using RERCPI, RUSNOM and NEER series but negative and significant when using REER series. As for the negative value, it is also similar to the arguments by Friedman (1953) that it is possible to have high output volatility leading to lower exchange rate volatility. This means that there are some traders who do not care about instability in a country they want to invest into as long as they will benefit at the end of it. This phenomenon is widely seen in countries with many natural resources, for example, gold or diamond and oil. Jabeen & Khan (2014) also finds a negative and significant relationship between output volatility and exchange rate volatility for Pakistan/US dollar currency. The insignificant output value confirms Flood & Rose (1995) claims that macroeconomic volatility is not an important source of exchange rate volatility.

3.7 Conclusion

This paper investigates the determinants of real and nominal exchange rate volatility using both bilateral (rand/US dollar) and effective exchange rates over the period 1986M2 —

2013M11 for South Africa. Using a GARCH(1,1) and an EGARCH(1,1) models, the study addresses two objectives: First, it tests the hypothesis, does openness decrease exchange rate volatility in South Africa? and second, what other macroeconomic factors causes exchange rate volatility? The results show that switching to a floating exchange rate system leads to exchange rate volatility increasing as hypothesised by some researchers(see e.g. Arezki et al. 2014, Ricci 2005). This follows the positive and significant dummy variable post March 1995 when South Africa liberalised its capital account. The results also show that openness decreases exchange rate volatility in South Africa using the real and nominal bilateral rand/US dollar, and that other macroeconomic factors also influence exchange rate volatility.

The results for macroeconomic factors are summarised as follows: Real gold price volatility increases exchange rate volatility. The significance of this variable in influencing exchange rate volatility is similar to the study by Arezki et al. (2014) who use a different method. Foreign reserves changes reduces exchange rate volatility which is in line with the finding by Hviding et al. (2004). Money supply influences exchange rate volatility negatively which suggest that increases in the interest rate leads to higher exchange rate volatility. The results also indicate that output volatility increases exchange rate volatility using bilateral exchange rate. However, when using real effective exchange rate, the results between output volatility and exchange rate volatility are the opposite. This is in line with the arguments by Friedman (1953) and the finding by Jabeen & Khan (2014).

However, the results indicate that real factors (commodity prices, output and openness) have higher magnitudes compared to monetary factors. Given that an increase in exchange rate volatility might hurt the economy via adverse effects on employment growth and trade, suggests that the South Africa government should focus more on real factors if they aim to reduce exchange rate volatility. For example, evaluating the costs of increasing openness and understanding the relationship between exchange rate volatility and fundamentals than just focusing on exchange rate level. This follows the recent debate as to whether capital controls are appropriate or not in view of surges in capital inflows into emerging markets. Given that monetary factors are also influencing exchange rate volatility implies that monetary authorities also have a part to play in reducing exchange rate volatility.

Chapter 4

Exchange Rate Volatility, Political and Macroeconomic Events in South Africa

4.1 Introduction

Over the years, several studies have analysed the movements of South Africa's exchange rate (the Rand). For instance, some researchers use the first moment analysis(Aron et al. 1997, MacDonald & Ricci 2004, Frankel 2007, Saayman 2007, Faulkner & Makrelov 2008) and others use the second moment analysis(Farrell 2001, Arezki et al. 2014, Mpofu 2015). These studies focus on economic theories that explain Rand movements over the medium to long-term periods. In many ways it is known that exchange rates are greatly affected by publicly announced information(Cosset & De La Rianderie 1985). The arrival of announcements/ events is mostly unanticipated and therefore surprises the traders in the foreign exchange markets. These sudden shocks often causes traders to either mark-up or down currencies over a short-run period which then influences the exchange rate movements. Given that events occur over a short-run period implies that a different method is required to analyse the Rand movements. This paper uses one such method which is an asset price approach. This follows some researchers (see e.g. Flood & Taylor 1996, MacDonald 1999, Morana 2009) who argue that exchange rates movements cannot always be explained by flow demand and supply components but by analysing market microstructures.

Given the above, this study contributes to the literature on the causes of exchange rate movements in several ways. Firstly, it uses an event studies approach á la Campbell, Lo & MacKinlay (1997). The advantage of an event study is that it is able to quantify systematically the abnormal or unexpected impact of a political or economic event on asset

prices like the exchange rate. Kothari & Warner (2004) argue that event studies focusing on announcement effects over a short-run period around an event provides evidence relevant for understanding corporate policy decisions especially on the wealth of the firms' claimholders on the stock market. They also argue that event studies focusing on long-term periods, that is longer event windows, are vital in testing market efficiency in capital market research. In addition, Fatum & M Hutchison (2003) argue that the use of an event study is appropriate because: first, events have an unusual distribution and second, events have the possibility of changing over longer periods. As such, the use of standard time series methods might be inadequate in trying to analyse the impact of events.

Secondly, the study focuses on an emerging market. Most studies using event studies approach on exchange rates have been mainly on developed economies such as the USA, the UK, Australia, Canada and New Zealand with few studies focused on emerging markets such as Turkey. Doing an analysis on emerging markets is important because these economies have been gaining prominence in international finance and trade yet they are generally small open economies. Such characterisation exposes emerging market economies to high levels of volatility in some of its key economic variables. One such variable is the exchange rate. Rising exchange rate volatility may hurt the economy through its adverse effects on employment growth and trade. The Rand is one of the most traded emerging market currencies. As such, its movements might be influenced by various events. The exposure of emerging markets to a mix of exogenous shocks is also important in the framework of monetary policy design.

Thirdly, few studies that use event studies approach in South Africa only focuses on stock prices(see e.g. Meznar et al. 1998, Gladysek & Chipeta 2012, Gupta & Reid 2013).

To analyse the short-run behaviour of the Rand, this study answers the following questions: First, what is the impact of South Africa's monetary policy announcements on the rand? Second, do political or socio-political events, for example, Marikana massacre, release of Nelson Mandela banknotes, and ANC elective conferences, have an impact on the Rand? These questions are important for a country like South Africa. This is so because South Africa has consistently been running a current account deficit, implying it relies heavily on foreign direct and portfolio investments to finance the deficit as well as for economic growth projects. Hence, political or socio-political events signals political risks of a country which eventually influences the decisions by the investors in foreign capital markets. For instance, negative aspects in the domestic economy might lead to capital flight which will adversely affect economic growth. This follows Barr & Kantor (2002) who assert that political uncertainty and economic growth have always been negatively associated in South Africa.

The exchange rate market is sensitive to a wide range of economic, social and political news. As such, when answering the above questions, only the monetary announcements which do

not coincide with the release of other economic news are used while only major political or socio-political events are considered. This follows the literature which states that its vital that the event day is precisely known and the fact that event studies in the foreign exchange markets may also be affected by the release of other events within the same day(Kwok & Brooks 1990). This study uses three exchange rates namely: Rand/US dollar, Rand/British Pound and Rand/Euro. These currencies are used because they are in the top four of the most liquid currencies in the world[1] and the fact that South Africa trades a lot with the European Union and the USA[2]. The key findings of the study are that 8 out of 12 monetary policy announcements have significant cumulative abnormal returns (CAR). The exchange rates' reaction to monetary policy are mixed. Sometimes an increase in the policy rate results in the appreciation of the exchange rates whilst during other times, an increase in the policy rate results in the depreciation of the currency. The study also finds significant CAR for all three exchange rates following the Marikana event on 16 August 2012 and the release of Nelson Mandela banknotes. The ANC elective conferences only have significant CAR using the Rand/US dollar. These results suggest that the Rand is not only influenced by demand and supply flows but also by news

The rest of the paper is organised as follows: Section 4.2 presents the literature review. Section 4.3 outlines the model framework. Section 4.4 describes the variables and the descriptive statistics of the data used. Section 4.5 presents the econometric approach used while section 4.6 presents the analysis of estimation results. Finally, section 4.7 concludes.

4.2 Literature Review

There are two strands of empirical literature related to the impact of news on exchange rates. The first strand models news as time series innovations in the relevant macroeconomic variables while the second strand models news as the difference between the actual and expected values of macroeconomic announcements(Galati & Ho 2003). Using the second strand, expectations are based on survey data from Bloomberg and Reuters news databases.

The empirical literature on the impact of news on exchange rates is based on the notion that if foreign exchange markets are efficient, then all anticipated relevant information should be incorporated in current exchange rates. This literature follows the study of Fama (1970)

[1]See page 10 of: Bank of International Settlements (2013), "Triennial Central Bank Survey. Foreign Exchange Turnover in April 2013: preliminary global results" Monetary and Economic Department. Cited at http://www.bis.org/publ/rpfx13fx.pdf

[2]See table 18.2 in Blanchard, O. & Johnson, D et al.(2014). Global and Southern African Perspectives: Macroeconomics, Pearson Holdings Southern Africa (Pty) Ltd. This table indicates that 21% of South Africa's exports go to European Union, 11.7% to China, 8.5% to the USA, 5.9% to Japan, 4.1% to India. The table also shows that 28.8% of imports into South Africa come from the European Union, 14.3% from China, 7.4% from the USA and 4.6% from Japan and India respectively.

whereby three forms of market efficiency are distinguished: First is the weakly efficient market hypothesis which states that the past series of exchange rates contains no information about the future spot exchange rates; second is the semi-strong market hypothesis which states that exchange rates fully reflect all publicly available information; and third is the strong form of market hypothesis which states that all information (both public and private) is reflected in exchange rates.

As noted in section one that a great deal of publicly announced information affects exchange rates, in this study a test of the semi-strong market hypothesis is performed. The idea is that the Rand is generally volatile but does the arrival of announcements/ events lead to further increases in Rand volatility (i.e. having significant abnormal and cumulative abnormal returns). If yes then it means that news significantly causes the Rand movements. If no then it means that news does not cause the Rand movements i.e. Rand volatility is susceptible to other factors besides news. This paper uses the first strand to model news following Frenkel (1981) who finds that during the 1970s unanticipated events were a major determinant of exchange rate movements. Frenkel's model calculates news as unexpected change in the interest rate differential using an autoregressive process. However, his results suggest only weak evidence for the role of news. Possible reason for the weak results is because he uses monthly data which is unlikely to capture the moment of surprise caused by the arrival of new information. Therefore, this study uses daily data which I expect to obtain better and significant results. The next section shows the modified version of Frenkel's model which has also been used recently but in a different approach to capture the impact of news by Stancık (2007).

Subsequent empirical literature using the first strand include Cosset & De La Rianderie (1985) who analyses the impact of political risk on foreign exchange market. Using daily data and narrow event window (e.g. -1,+1 or +2), they find significant abnormal returns. This means that political risk affects a country's investment climate and causes its currency to vary. Their results also shows that unfavourable events cause the foreign exchange market to react more dramatically than favourable events. Using daily data, Adam, Koziński & Zieliński (2013) investigate to what extent can central banks influence exchange rate with foreign exchange interventions when an economy has an inflation targeting system. Analysing the behaviour of the exchange rate over the 5-day event window, they find significant abnormal returns which led to Polish zloty appreciating on average against the Euro by 0.6%. Their results also show that the implied volatility decreased during the same 5-day window. Hence their results suggest that the central bank can influence the exchange rate even when they do not explicitly target it. Fatum & M Hutchison (2003) also find that sterilised foreign exchange intervention is effective in influencing the exchange rate using 2, 5, 10 and 15-day pre- and post event window.

By reviewing studies in Turkey that use event studies method, Basdas & Oran (2014) state that the definition of events and their design changes amongst studies which makes it difficult to generalise inferences about different types of announcements. They show that event studies that analyses the impact of political events on asset prices, for example, stock market find mixed results (some significantly impacting the stock prices while others do not). This is due to different estimation windows and event windows.

To the best of my knowledge, no study has been done in South Africa using the first strand approach to find the impact of news on the exchange rate. Thus this paper contributes to the literature on the causes of exchange rate movements in emerging markets using the first strand event studies approach. The studies that have been done are either restricted to stock market reaction to announcements/ events(see e.g. Meznar et al. 1998, Gladysek & Chipeta 2012, Gupta & Reid 2013) or the exchange rate using the second strand (see e.g. Fedderke & Flamand 2005, Farrell, Hassan & Viegi 2012)[3].

The strand of literature using the second approach are based on regressions whereby the dependent variable is the percentage change in the exchange rate over the event window and the independent variables are a constant used to capture any trend and the percentage change in the market interest rate over the same event window[4]. These studies focus on the impact of monetary policy announcements on the exchange rates. The market interest rate is used by these studies to focus on the policy shocks rather than the policy actions. Kearns & Manners (2006) assert that monetary policy decisions are widely anticipated by the market. As such their impact should already be incorporated into interest rates and exchange rates. As a result, there is a need to use the surprise component of the monetary policy. Besides Bernanke & Kuttner (2005) state that unexpected policy actions corrects for endogeneity and simultaneity.

Using a 2-day event window around the announcements of monetary policy, Zettelmeyer (2004) finds that a 1% point increase in the market interest rate appreciates the exchange rates for Australia, Canada and New Zealand on average by 2-3 percent. Kearns & Manners (2006) use the same technique but with intraday data and find similar results of exchange rates appreciating for the UK, Australia, Canada and New Zealand. They state that their results show that the surprise in monetary policy explains only 10—20 percent of the movement in the exchange rate. A result they state suggests that monetary policy only explains a small part of the observed exchange rate volatility[5]. Faust, Rogers, Wang & Wright (2007)

[3]Fedderke & Flamand (2005) analyse the impact of macroeconomic surprises for the following variables: CPIX, PPI, Repo rate, GDP, money supply and trade deficit/surplus on the rand/US dollar exchange rate for the period June 2001 to June June 2004. Farrell et al.(2012) analyse the impact of inflation surprises on rand/US dollar exchange rate for the period 1997 to 2010.

[4]The equation looks as follows: $\Delta e_t = \alpha + \beta \Delta i_t^{mkt} + \varepsilon_t$.where Δ refers to change, e_t is the exchange rate, α is the constant, β is the parameter, i_t^{mkt} is the market interest rate.

[5]Exchange rate volatility is measured as the average absolute change in the exchange rate over ten-minute

find similar results to Kearns & Manners', that tightening by the Federal Open Market Committee(FOMC) leads to the appreciation of the US dollar.

4.3 The Model

To motivate the empirical approach in section five, a simple framework which links exchange rate movements and news is postulated in this section. A simple market model is used because Brown & Warner (1985) argue that simple risk-adjustment approaches perform well in conducting short-run event-window studies as well as being effective in detecting abnormal performance. Using simulations Kwok & Brooks (1990) show that simple market models have the best performance over mean-adjusted model, simple random walk model and market-adjusted model [for example, capital asset pricing model (CAPM) and arbitrage pricing theory (APT)].

This model is also used because it has theoretical underpinnings. It is based on rational expectations hypothesis by Dornbusch (1979) and modifications by Frenkel (1981). That is the model is a combination of efficient market hypothesis and uncovered interest rate parity (UIP).

Assuming that asset markets clear fast and that the news is immediately reflected in changes in the rates of interest together with Dornbusch's decomposition, Frenkel (1981) proposes a model for estimating the effect of news on exchange rate volatility as follows:

$$\ln S_t = \beta_0 + \beta_1 \ln F_{t-1} + \beta_2[(i - i^*)_t - E_{t-1}(i - i^*)_t] + \omega_t \tag{4.1}$$

where S_t is the spot rate, F_{t-1} is the lagged forward exchange rate, i is the domestic interest rate, i^* is the foreign interest rate and $E_{t-1}(.)$ is the interest differential expected at time t based on information at time $t-1$. $E_{t-1}(.)$ is found by regressing interest rate differential on a constant, two-lagged values of the interest rate differential and the natural logarithm of one-lagged forward exchange rate. The first two components on the right-hand-side of equation 4.1 represent the expected exchange rate and the term in brackets represents news. Hence news is calculated as unexpected change in the interest rate differential using an autoregressive process.

However, Frenkel estimates equation 4.1 using exchange rate in levels ($\ln S_t$) yet this variable might be non-stationary. Implying equation 4.1 should be estimated using the exchange rate in first difference ($\Delta \ln S_t$). Furthermore, he uses monthly data which might not capture the

intervals.

moment of surprise caused by new information which changes fast on daily basis. Besides, other studies (Brown & Warner 1985, Kothari & Warner 2004) argue that using daily data leads to more precise pinpointing of an event. Accordingly, this paper estimates the following model which is a modification of equation 4.1:

$$\Delta \ln S_t = \beta_0 + \beta_1 \Delta \ln F_{t-1} + \beta_2[(i - i^*)_t - E_{t-1}(i - i^*)_t] + \epsilon_t \tag{4.2}$$

where $\Delta \ln S_t$ is the first difference of the exchange rate, β_0, β_1 and β_2 are parameters, $\Delta \ln F_{t-1}$ is the one-lagged forward exchange rate. A different specification will use $\Delta \ln S_{t-1}$ instead of $\Delta \ln F_{t-1}$. As discussed by Basdas & Oran (2014) different tests should be done for modeling the normal returns which are used to measure the abnormal returns. They argue that the choice of the model(s) is one of the most important parts in using event studies.

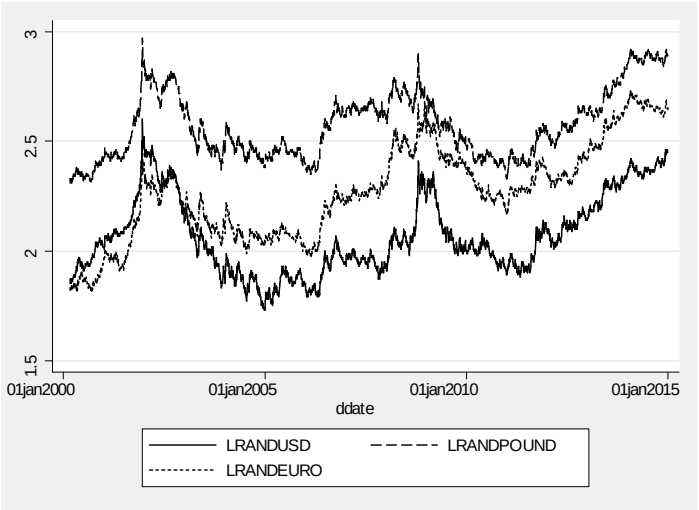
4.4 Data and Descriptive Statistics

4.4.1 Data

This paper uses daily data for South Africa from 1 March 2000 to 31 December 2014 obtained from South African Reserve Bank (SARB), Datastream and Bloomberg. The variables used are exchange rates, interest rate and the events. Nominal spot exchange rates for South African Rand/US dollar, South African Rand/British pound and South African Rand/Euro are used. Using this definition implies that an increase in the spot exchange rate is depreciation while a decrease is an appreciation. The values are Reuters closing spot rates provided at or around 16:00hrs in London. This time reflects the middle of the global day and the time of highest liquidity in the foreign exchange market. Figure 1 shows the trends of South African exchange rates. This graph indicates that the Rand/US dollar, Rand/pound and Rand/euro depreciated on average during the following periods: March 2000 – December 2001, April 2006 – October 2008 and June 2011 – December 2014 while these currencies appreciated on average during the following period: January 2002 – April 2006 (during which the Rand/US dollar, Rand/pound and Rand/euro appreciated by 56 percent, 46 percent and 42 percent respectively) and October 2008 – June 2011. The appreciation between 2002 – 2006 was due to commodity price boom during that period.

The most notable sharp exchange rate changes are observed between June 2001 and December 2001 during which the Rand/US dollar, Rand/pound and Rand/euro depreciated by 67 percent, 48 percent and 77 percent respectively. This was probably due to Argentina crises in 2001– 2002 and the September 2001 terrorist attack in the USA. Another sharp

Figure 4.1: South African exchange rates, 1 March 2000-31 December 2014



depreciation occured between September 2008 and October 2008 during which the Rand/US dollar, Rand/British pound and Rand/Euro depreciated by 43 percent, 29 percent and 26 percent respectively. This was due to the beginning of the 2008/2009 global financial crises given that during this period the Lehman Brothers filed for bankruptcy on 15 September 2008. These trends indicate that the Rand does respond to events but the question that one asks is, does the event in question lead to significant abnormal changes in the movements of the Rand? Only empirical analyses can answer such questions as this paper does in section six. Forward exchange rates for South African Rand/US dollar, South African Rand/British pound and South African Rand/Euro are used. 1-week forward exchange rates are used given that the study is focusing on the short term behaviour of the exchange rate.

South Africa's three month treasury bill interest rate in daily frequency is used. The monetary policy surprise is calculated as the change in the three-month treasury bill interest rate around monetary announcement. The surprise can be nonzero even when the policy interest rate did not change because the market might have placed at least some probability on there being a change.

Two types of events are used. These are major political events and monetary policy announcements in South Africa. The political events include the Marikana massacre, the ANC elective conferences and the release of Nelson Mandela banknotes[6]. Table 4.1 provides the description of these political events.

Since the inception of inflation targeting system, South Africa's monetary policy committee

[6]Given the focus on major political events, the national elections that took place in 2004, 2009 and 2014 also qualify to be analysed. However, this study does not analyse them because the results of the elections are always announced on a Saturday when there are no exchange rate figures. Thus the announcement date cannot be determined explicitly and clearly.

Table 4.1: South African major political events

Dates	Description
16 August 2012	Marikana Massacre
16–20 December 2002	ANC elective conference
16–20 December 2007	ANC elective conference
16–20 December 2012	ANC elective conference
6 November 2012	Release of Nelson Mandela banknotes

Notes: The Marikana massacre is the result of the strike by mining workers. The ANC elective conferences usually takes place after every five years to choose the individual to lead the ANC party as their president and other five top posts

(MPC) has met 95 times. To examine the immediate response of the exchange rate to monetary policy announcements requires the use of a narrow event window. This is achieved through careful reading of the central bank statements after each MPC meeting and South Africa's economic releases on Bloomberg to ensure that no other announcements/events were made on the same day as the monetary announcements. This is done to eliminate contaminated events which might mislead the true measure of the surprise policy in MPC announcements. This include changes made after 11 September 2001 terrorist attacks, events that coincide with changes in the federal funds rate, changes in response to spillover crises from other countries and events happening on the same day that might affect market interest rate. Table 4.2 provides a summary of South Africa's monetary policy events while table C.2 documents the description of the events mentioned in table 4.2.

<Insert table C.2 here>

After finding the monetary policy announcements released on days when other macroeconomic events are not released, I then calculate the monetary policy surprise. Figure C.1 shows the monetary policy surprise which is constructed using the change in the three-month treasury bill interest rate on the day after and the day the MPC announces the official repo rate.

Exchange rate volatility measured as the average absolute percent change in the exchange rate between the day of announcement and the day before, is higher on the announcement day than on nonevent days. This is shown in table 4.3 which provides some initial evidence that monetary policy has an effect on the exchange rate. But how has Rand volatility behaved over the study period. Table C.1, shows the rank ordered volatility of twenty

Table 4.2: South African monetary events (1 March 2000—31 December 2014)

Description	Monetary Announcements
Number of Events used	54[b]
Number of changes	19
Number of No-changes	35
Meetings per year[a]	6

Notes:a MPC usually meets 6 times per year. Exception include the year 2000(8times), 2001(7times), 2002(5times) and 2009(9times).Special meetings not announced in advanced and meetings on unscheduled dates without announcements in advance for changes are excluded.
b changes overshadowed by 11 Sept 2001 terrorist attacks in the USA; Zimbabwe problems, Argentina crises and fears of debt default in Brazil in 2002 are excluded.Events that coincide with Federal funds rate announcements or occur just one day after Fed announcements are also excluded. South African events that occur on the same day as monetary announcements which are believed to influence market interest rate or exchange rate are also excluded e.g. releases of CPI/PPI by Bureau of Economic Research of the University of Stellenbosch,current account as %GDP, Trade balance, Net or gross reserves, GDP, business confidence etc.

Table 4.3: The Data

	R/US$	R/Pound	R/Euro
Number of Events Used	54	54	54
Ratio of Event to Nonevent day Exchange Rate Volatility[a]	1.42	1.17	1.24
Average $\lvert\Delta e_{[t_0-t_{-1}]}\rvert$	0.84	0.82	0.77

Notes:[a]The volatility is calculated as the average absolute percent change in the exchange rate on the day of announcement and the day prior. The sample of nonevent is constructed by taking the day exactly one week prior to announcement day. Average $\lvert\Delta e_{[t_0-t_{-1}]}\rvert$ is the absolute percent change in the exchange rate on the day of monetary announcement and the day before.

selected major emerging market (EM) currencies over the study period. This table indicates that the Rand is the most volatile currency among the selected EM currencies over the study period constituting 9.3% of the total volatility whose median and mean volatilities are 5.0% and 5.45% respectively. Dividing the entire period into two, that is, period before and after 2008/2009 global financial crises, the Rand is still the most volatile currency before the crises but its the second most volatile currency after the crises.

<Insert table C.1 here>

The next question is, what changes have taken place as far as monetary policy and political developments are concerned in South Africa over the study period? The rest of this section briefly outlines the current monetary policy regime, the political developments and how these changes influence this study. This follows the fact that since 1994, there have been major changes in the monetary policy operations in South Africa (Du Plessis 2002, Aron &

Muellbauer 2007, Ndikumana 2008) as well as the political developments.

Currently, South African Reserve Bank (SARB) follows an Inflation Targeting (IT) system which it adopted in February 2000. This was adopted with the aim of achieving the central bank's primary objective of price stability given that under IT, a precise numeric target inflation rate is specified. The target range for South Africa has been between 3 — 6 percent though for the years 2004 and 2005, it was changed to between 3 — 5 percent[7]. Under IT, the monetary policy committee (MPC) decides on the appropriate monetary policy stance following fixed announcements dates for policy decisions. These dates are usually provided before the beginning of the new year due to central bank's preference not to surprise the market. However, there are options to make changes to these dates in response to extreme events. The MPC meets to deliberate and at the conclusion of every meeting, a statement is issued through a press conference by the Governor of the bank explaining their stance of either increasing, decreasing or no-change to their policy instrument (the repurchase rate or the REPO rate in short).

For the exchange rate policy, the SARB does not target any particular exchange rate level under the current monetary policy. This is due to the trilemma in international economics which states that a country can only choose two out of the following three policies at once: a stable foreign exchange rate, free capital movements and an independent monetary policy. However, foreign exchange interventions are not excluded from the monetary policy toolbox as long as its done to ensure macroeconomic and financial stability. For instance, according to SARB, its participation in the foreign exchange market is to build up the foreign exchange reserves and should be seen as the management of international liquidity and not the exchange rate policy. However, the announcements of the REPO rate signals the eventual behaviour of the market interest rates which in turn influences the movements of the exchange rate. This suggests that the rand might be volatile due to monetary policy actions, hence the need to investigate the impact of monetary policy announcements on the short term behaviour of South Africa's exchange rate. The SARB operations is important because it assisted in choosing the time period of the study and the events. For example, this study only focuses on the period after the adoption of IT. This is so because it gives us events in which causality of the monetary policy surprise is likely to run in one direction, that is, from interest rates to exchange rate as argued by Kearns & Manners (2006).

As for political developments, the African National Congress party (ANC) has been in power since the democratic elections in 1994. Since then, the ANC government has introduced

[7]See the monetary policy statements by Mr.T.T. Mboweni on 6 April 2000 and 15 November 2001 cited at https://www.resbank.co.za/Publications/Detail-Item-View/Pages/Publications.aspx?sarbweb=3b6aa07d-92ab-441f-b7bf-bb7dfb1bedb4&sarblist=21b5222e-7125-4e55-bb65-56fd3333371e&sarbitem=4337 and https://www.resbank.co.za/Publications/Detail-Item-View/Pages/Publications.aspx?sarbweb=3b6aa07d-92ab-441f-b7bf-bb7dfb1bedb4&sarblist=21b5222e-7125-4e55-bb65-56fd3333371e&sarbitem=4324

many reforms following the establishment of the new constitution. One of the reforms is the main labour law[8]. The LRA states that every worker has the right to form and join a trade union, to participate in the activities and programmes of a trade union and to strike. This is important because it has an impact on this study given that some strikes tend to become violent and this influences the behaviour of the exchange rate. For example, the Marikana massacre on 16 August 2012 led to the Rand/US dollar, Rand/British pound and Rand/Euro depreciating by 1.86 percent, 2.21 percent and 2.31 percent respectively from the date before the strike began. The depreciation is taken as a negative response whilst appreciation is taken as a positive response. Using the same analysis, the ANC elective conferences between 16 — 20 December 2002 and 2007 had a negative response while the conference between 16 — 20 December 2012 had a positive response because all the three currencies depreciated in 2002 and 2007 but appreciated in 2012.

4.5 Econometric Approach

To find the answers to the research questions posed in section 1, this study uses the event studies approach. This is due to the fact that the exchange rate has similar characteristics as asset prices like stock prices, where most studies have used this method to assess the effects of events on share prices. Campbell et al. (1997) argue that due to rationality in market places, the effect of an event will be reflected immediately in asset prices. Hence the economic impact of an event can be measured using asset prices observed over a relatively short time period.

Campbell et al. (1997) assert that there is no unique structure of applying the event study but the analysis can be viewed as having seven steps. These are: defining the event of interest, selection criteria, calculation of normal and abnormal returns, choice of estimation procedure, testing procedure, empirical results and interpretation of results. Accordingly, the events of interest are: South African monetary policy announcements, political events of Marikana massacre on 16 August 2012, ANC elective conference on 16 — 20 December 2002, 2007 and 2012 and the release of Nelson Mandela banknotes on 6 November 2012.

The goal of the event study is to measure the abnormal performance in the event period which covers the event date. This is achieved via the calculation of the normal and abnormal returns. The normal return is defined as the return that would be expected if the event did not take place. Campbell et al. (1997) state that there are two common methods of modeling the normal return. First is the constant mean return model and second, is the market model. This study uses the market model to estimate the normal performance which can be written

[8] see the Labour Relations Act (LRA) 66 passed in 1995.

as follows:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{4.3}$$

where R_{it} and R_{mt} are the period-t returns on exchange rate i and the market returns[9] respectively. Three exchange rates are used in this study namely; Rand/US dollar, Rand/British pound and Rand/Euro. Equation 4.2 in section 3 shows the market model which is a simple risk adjustment approach. This approach is used following Brown & Warner (1985) who argue that simple risk-adjustment approaches perform well in conducting short-term event-window studies as well as being effective in detecting abnormal performance. α_i is the intercept, β_i is the systematic risk of exchange rate i and ε_{it} is the residuals of the market model. The normal performance is estimated over the estimation period. This study uses 100 days prior to the event window as the estimation period. This follows the studies like Campbell et al. (1997) who state that using daily data together with the market model requires that the parameters of the model are estimated over 120 days prior to the event. Basdas & Oran (2014) assert that the literature claims that the average range of estimation period using daily data is between 100 and 300 days inclusive.

Abnormal return (AR) is defined as the actual ex post return of the asset price over the event window minus the normal return of the asset price over the event window. The abnormal returns are calculated as follows:

$$AR_{it} = \varepsilon_{it} = R_{it} - E[R_{it}|X_t] \tag{4.4}$$

where ε_{it} is the abnormal return for a specific asset price i, R_{it} is the actual return, $E[R_{it}]$ are normal returns and X_t is the conditioning information for the normal performance. The cumulative abnormal return (CAR) for exchange rate i over the event windows is calculated as follows:

$$CAR_{i,(T_1,T_2)} = \sum_{t=T_1}^{T_2} AR_{it} \tag{4.5}$$

where T_1 is the first day of the event window and T_2 is the last day of the event window. The period for the event window for each political event is as follows. Marikana massacre is between 13 August 2012, the first trading day after the strike began and 17 August 2012, the day after the shooting. This represents a 5-day event window. For Nelson Mandela banknotes release, the event window is between 5 November and 7 November 2012 inclusive

[9] This is the risk factor adjusted.

which represents a 3-day event window. ANC elective conference of 2002, the event window is between 16 and 20 December 2002 with the announcement date being 18 December 2002 which shows a 5-day event window. The ANC elective conference of 2007, the event window is between 17 and 20 December 2007 with the announcement date being 18 December 2007. This indicates a 4-day event window. Lastly, the ANC elective conference of 2012, the event window is between 17 and 20 December with the announcement taking place on the 18th of December. This shows a 4-day event window.

For monetary policy announcements, the event window comprises the day before the announcement, the day of announcement and the day after the announcement. That is, its a 3-day event window. Based on information from figure C.1, 12 monetary policy announcements are analysed in this paper.

As for testing procedure, this study uses a t-test given that the basis for inference in event studies is a test statistic(Brown & Warner 1985). Table 3 of Basdas & Oran (2014) provides some of the proof given the large number of studies which uses the t-test. Moreover, Kwok & Brooks (1990) argue that though the assumption of normality may be violated when using parametric tests, for example, t-test, compared to non-parametric tests, the t-test is robust enough to detect the absence or presence of abnormal performance.

4.6 Results

The goal of event studies is to measure the abnormal performance of the asset price in question over the event period. To achieve this goal, this study answers the research questions posed in section 1 by analysing 12 surprise monetary policy announcements and 5 political events on South African Rand. This is done by testing the significance of cumulative abnormal return (CAR) using the t-statistics. For monetary policy announcements, a 3-day event window is utilised (i.e. -1, +1) while for political events, various event windows are used (-1,+1; -2,+1; -3,+1). Event windows are chosen in such a way that it captures the short term abnormalities in the exchange rate returns. This follows the theory presented in section 3 which states that the impact of news clears fast and immediately. This implies that having long event windows might not find significant impact of news.

The results of t-test for political events are presented in table C.3. This table shows whether the CAR of an exchange rate is statistically significant on the event date in each event window or not. Two models are estimated to calculate the normal performance. However, the results indicate that there is not much difference between the two models given the small difference in the coefficients of the CAR for each exchange rate. This is so because the correlation matrix between lagged spot exchange rate and the lagged 1-week forward

exchange rate is 0.9998, 0.9995 and 0.9960 for the Rand/US dollar, Rand/ British pound and Rand/Euro respectively.

<Insert table C.3 here>

The results indicate that there were significant abnormal returns on the three exchange rates used in this study following the Marikana event. The Rand/US dollar is significant at 5% while Rand/British pound and Rand/Euro are significant at 1%. The positive effect implies that the Marikana Massacre on 16 August 2012 which left 34 mining workers dead had significant depreciation effects on all three exchange rates. This was considered as the deadliest police action since the end of Apartheid. These results confirm the descriptive statistics mentioned in section 2 earlier and it is inline with my a priori knowledge that labour unrests causes exchange rates to depreciate. This follows the notion that labour unrests are generally viewed as a socio-political risk factor. The depreciation is taken as a negative/bad effect given it signals the loss of value of the currency while an appreciation is taken as a positive/good effect. The depreciation follows the definition of the spot and forward exchange rates as explained in the data description section. In addition, the depreciation is also considered as a bad effect for the Marikana event because such perceptions of South African political risks might cause negative growth effects. This follows the notion that South Africa relies heavily on foreign and portfolio investments to fund its current account deficit and economic growth projects. Hence such events might cause investors in the capital markets to reverse their investments given they might view that their investments are at risk. This is inline with the arguments by Barr & Kantor (2002).

The release of Nelson Mandela banknotes on 6 November 2012 had significant abnormal effects on the returns of all three exchange rates. The Rand/US dollar is significant at 10% while the Rand/British pound is significant at 5% and the Rand/Euro is significant at 1%. The negative coefficient implies that the release of these banknotes led to a significant appreciation of the three exchange rates. The positive effect of these results might be due to the fact that Nelson Mandela is/was considered as an icon by both domestic and international population.

As for ANC elective conference, the results indicate that the Rand/US dollar is significant for 2007 and 2012 conferences while insignificant for 2002 conference. These results show that the Rand/US dollar depreciated significantly after the announcement of the ANC elective conference in 2007 while the Rand/US dollar appreciated significantly following the 2012 elective conference. This also confirms the descriptive statistics mentioned in section 2 earlier. However, the political events of ANC elective conferences of 2002, 2007 and 2012 had no significant abnormal returns on the Rand/British pound and Rand/Euro exchange rates.

The negative effect on the Rand/US dollar of the 2007 conference is due to significant changes in the leadership of the ANC since the 1997 conference[10]. This follows the notion that it was uncertain as to what will happen at this conference given the rivalry for the presidency of the party between Thabo Mbeki and Jacob Zuma. Prior to this conference, Thabo Mbeki was the president for the country and the ANC party, and was seeking for the third term as ANC party president given that he was required to step down as country president at the end of his second term in 2009. On the other hand, Jacob Zuma wanted to be the party president to increase his chances of becoming the country president come 2009. During the ANC elective conference, the highest decisions on future policies and programmes of the party are made such as adoption of constitutional amendments. The announcement of Jacob Zuma winning the party presidency might have been viewed by foreign exchange traders as future political uncertainty.

Overall, these results indicate that the South African Rand responds to political events. The results also show that the Rand/US dollar responds to political news more than the Rand/British pound and Rand/Euro given more significant cumulative abnormal returns on the day of the event. Possible reasons for the Rand/US dollar results is due to the US dollar being the most used currency in most financial and trade transactions. Meaning many people pay more attention to the performance of the US dollar such that it then makes any domestic currency/US dollar to also be given more attention. The results also indicate that unfavourable political events have larger magnitude than favourable political events. The significance of political events affecting exchange rates found in this study is similar to studies like Cosset & De La Rianderie (1985) as well as studies finding the impact of political news using a t-test on stock price returns given that they are all asset prices(see e.g. ERYİĞİT 2007, Basdas & Oran 2014).

Results for the impact of monetary policy announcements on South African Rand are presented in tables C.4, C.5 and C.6. These tables indicate the t-test for Rand/US dollar, Rand/British pound and Rand/Euro respectively. Based on these tables, the results show 8 out of 12 cases where at least one exchange rate has significant cumulative abnormal returns.

<Insert tables C.4, C.5 and C.6 here>

The results show that in two occasions where all three exchanges rates have significant cumulative abnormal results, they all react to monetary policy announcements in the same direction. For instance, following the monetary announcement on 13 October 2002 of 100 basis-points increase in the repurchase rate, all three exchange rate depreciates. On the other hand, all three exchange rates appreciates following a 50 basis-points increase in the repurchase rate. Unlike other studies (see e.g. Zettelmeyer 2004, Kearns & Manners 2006) that use the second strand of literature as explained in the literature review and find that an

[10] http://www.sahistory.org.za/article/anc-national-conference-1991-2013

increase in the monetary policy surprise (measured using the change in the market interest rate) results in the appreciation of the exchange rates, this study finds mixed results. The mixed results might be the support of the failure of uncovered interest rate parity condition as has been empirically found(Engel 1996).

Possible explanation for these results might be the expectations of inflation and or economic growth by foreign exchange traders. Hence depending on the weight being put on inflation or economic growth as a result of monetary policy announcement, an increase (decrease) in the policy rate might result in good news(bad news) or vice-versa by the foreign exchange traders. To support this, Farrell et al. (2012) find that since the adoption of inflation targeting system, the Rand/US dollar appreciates on impact due to bad news about inflation (i.e. inflation higher than expected) but depreciates due to good news.

4.7 Conclusion

This paper investigates the impact of South African monetary policy announcement on the Rand using an event studies approach as well as the impact of political events on the movements of the rand. Three exchange rates for the Rand are used, that is, Rand/US dollar, Rand/British pound and Rand/Euro. These exchange rates are used because they are in the top four of the most liquid currencies in the world. The exchange rate is defined such that an increase in the spot rate rate is depreciation while a decrease is an appreciation. To measure the immediate impact of monetary policy announcement on the rand, the sample period used is between 1 March 2000 and 31 December 2014. This period is chosen because it ensures that the policy change is exogenous to the exchange rate given that South African government adopted inflation targeting in February 2000 where they do not target a specific exchange rate level. Further endogeneity issues are avoided through careful reading of the central bank statements and Bloomberg reports to ensure that only monetary policy events that do not coincide with other macro accouncements are included.

The results indicates significant cumulative abnormal returns in 8 out of 12 cases following the announcement of monetary policy. As for the exchange rate movements, the results are mixed. That is, following an increase in the policy rate, sometimes the exchange rates appreciates and sometimes depreciates.

The results for political events indicate that the three exchange rates had significant cumulative abnormal returns following the Marikana massacre and the release of Nelson Mandela banknotes. The Marikana event had a significant negative/bad effect on the exchange rates given the depreciation of all the three currencies while the release of Nelson Mandela banknotes had a significant positive/good effect on all the three exchange rates given the

appreciation of the three aforementioned currencies. The ANC elective conferences had significance on the Rand/US dollar in 2007 and 2012 only while the rand/pound and rand/euro were not affected by all three ANC elective conference due to no significant cumulative abnormal returns on the day of announcement. Overall, these results suggest that the South African Rand does respond to political and macroeconomic news.

Chapter 5

Conclusion

5.1 Summary of Findings

This thesis investigates three separate but related topics on the effects and causes of exchange rate volatility. The first paper presented in Chapter 2 investigates the impact of real exchange rate volatility on manufacturing employment growth. Using quarterly data covering the period 1995:3—2010:4, the study employs an Autoregressive Distributed Lag (ARDL) cointegration approach. The study confirms that an increase in real exchange rate volatility causes manufacturing employment to decline. The results also show that increasing output has a positive effect on manufacturing employment. The thesis has also indicated that increases in wages and interest rates results in manufacturing employment decreasing. These results suggest that the South African government should implement policies that minimises exchange rate volatility if they are to help in reducing unemployment problem in the country. This follows the notion that the manufacturing sector is vital for economic growth and employment creation due to possible spillover effects from this sector to the rest of the economy.

In the second paper presented in Chapter 3, the thesis employs GARCH models to find the determinants of exchange rate volatility in South Africa covering the period 1986M2—2013M11. The thesis contributes to the debate on exchange rate matters in South Africa by focusing on the second moment of the exchange rate unlike the first moment as has been done by many studies in South Africa. The results provide evidence that switching to a floating exchange rate regime leads to exchange rate volatility increasing. The study also shows that increased openness causes the exchange rate volatility to decline using bilateral exchange rate for the Rand/US dollar. The study also provides evidence that output, commodity prices, money supply and foreign reserves volatilities significantly influences exchange rate volatility. The study shows that real factors(commodity prices, output and openness) have relatively

larger effects on exchange rate volatility compared to monetary factors(money supply and foreign reserves). These results suggest that the government of South Africa should focus more on real factors to reduce exchange rate volatility.

The third paper presented in Chapter 4 analyses the short term behaviour of the South African rand using daily data. The study contributes to the literature by employing an event studies approach to find the impact of South Africa's monetary policy announcements and major political events on the rand. The results provides evidence that a surprise monetary policy announcement significantly influences the movements of the rand given significant cumulative abnormal returns. The results suggest that the rand is not only determined by demand and supply flows as done is Chapter 3 but also by news. Chapter 4 also finds that political events significantly influences the rand given the significance of the cumulative abnormal returns of the three exchange rates used on the event day on 16 August 2012 (Marikana massacre) and the release of Nelson Mandela banknotes on 6 November 2012. The results also indicate that the cumulative abnormal returns for the ANC elective conferences in 2007 and 2012 were significant for rand/US dollar exchange rate.

The analysis on the determinants of exchange rate volatility finds that economic openness influences exchange rate volatility. Future extension of this study should focus on investigating the impact of specific controls on exchange rate volatility performance. This will be done to find possible solutions for reducing exchange rate volatility. The study also confirms that monetary policy influences the exchange rate. Further research can explore the impact of SARB's participation in the foreign exchange market using event studies to enhance the robustness of monetary policy in influencing the exchange rate.

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Appendix A

Appendix to Chapter 2

Table A.1: South Africa vs Malaysia

Country	Y/L	(K/Y)	H/L	A	Mining share of GDP
South Africa	0.25	0.959	0.568	0.46	0.111
Malaysia	0.267	1.004	0.592	0.45	0.103

Source: Rodrik (2008)

Table A.2: Unit Root Tests using Augmented Dickey-Fuller method

	ADF-Statistic		Prob
Variables	Levels	First-Difference	
Employment	-1.9368		0.6232
		-7.4954***	0.0000
Volatility	-1.8156		0.6841
		-7.6992***	0.0000
RER	-1.9976		0.5906
		-5.9004***	0.0000
Output	-2.0181		0.5798
		-3.8505***	0.0002
Wages	-2.4339		0.3589
		-2.2210**	0.0266
Interestr	-3.8216**		0.0220
		-4.7590***	0.0000

Notes: ***, **, * means significant at 1%, 5% and 10% respectively.
Variables are defined as in section 4.

Figure A.1: GDP by production sectors 1994-2012

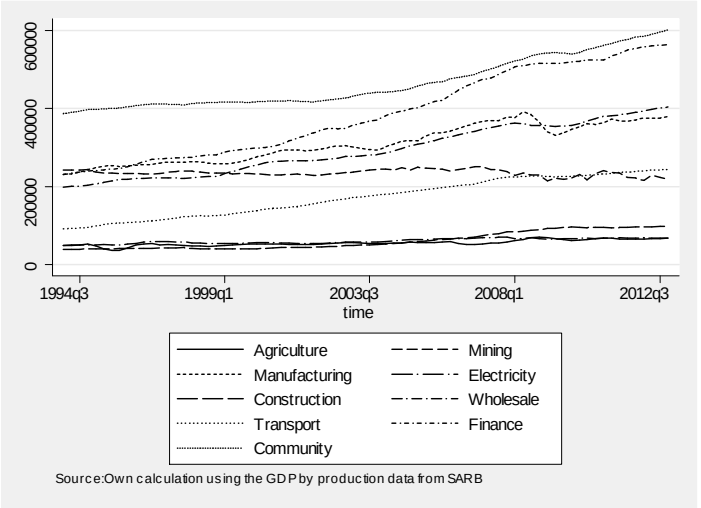


Table A.3: Unit Root Tests using Phillips-Perron method

	PP-Statistic		Prob
Variable	Level	First-Difference	
Employment	-2.1134		0.5280
		-7.5084***	0.0000
Volatility	-2.4839		0.3348
		-4.9409***	0.0000
RER	-1.7494		0.7168
		-5.8754***	0.0000
Output	-2.0181		0.5798
		-3.8505***	0.0002
Wages	-2.5516		0.3033
		-8.1601***	0.0000
Interestr	-2.4397		0.3562
		-4.5976***	0.0000

Notes: ***, **, * means significant at 1%, 5% and 10% respectively
Variables are defined as in section 4.

Table A.4: The Bounds Testing Procedure for the existence of a unique cointegrating vector

Dependent variable	Employment	Volatility	RER	Output	Wages	Interestr
F-Statistic	5.7133***	1.3590	1.9438	3.0594	2.2056	2.3270

Notes: *** means significant at 1%. The critical values for the case of unrestricted intercept and trend for k=6 are Lower bound I(0)=3.60 and Upper bound I(1)=4.90 (using Peseran et al. 2001)

Table A.5: Long Run Coefficients for ARDL

Dependent variable is Lemployment							
	Model 1			Model 2			
Variable	Coefficient	T-Ratio	P-value	Variable	Coefficient	T-Ratio	P-value
Volatility	-0.0219**	-2.4826	0.018	Volatility	-0.8312**	-2.5195	0.016
RER	-0.0319	-0.9259	0.361	REER	0.0321	0.6108	0.545
Output	1.5989***	6.5192	0.000	Output	1.4633***	6.8245	0.000
Wages	0.4028	2.4434	0.120	Wages	0.5334	3.8032	0.101
Interestr	-0.0034	-0.8251	0.415	Interestr	-0.0076*	-1.8600	0.071
INPT	-7.2186**	-2.2382	0.032	INPT	-6.4267**	-2.2672	0.029
Trend	-0.0164***	-8.5816	0.000	Trend	-0.0168***	-9.2311	0.000
Find0809	-0.0285	-1.4097	0.167	Find0809	-0.0394**	-2.0842	0.044
eea98	0.0023	0.1059	0.916	eea98	0.0033	0.1580	0.875
bcea97	-0.0199	-0.7664	0.449	bcea97	-0.0262	-1.0349	0.308

Notes: ***, **, * indicates significance at 1%, 5% and 10% respectively. INPT refers to a constant. find0809,eea98 and bcea97 are dummy variables. See section 4 for definition.

Table A.6: Error Correction Representation(ECM) for ARDL Model

Dependent variable is dLemployment					
Model 1			Model 2		
Variable	Coefficient	P-value	Variable	Coefficient	P-value
dvolatility	-0.0137**	0.032	dvolatility	-0.5271**	0.031
drer	-0.0132	0.768	dreer	0.0085	0.875
drer1	-0.0878*	0.074	dreer1	0.0883	0.101
doutput	0.3531*	0.079	doutput	0.4063**	0.033
doutput1	-0.3055	0.137	doutput1	-0.3440*	0.092
doutput2	-0.4242**	0.046	doutput2	-0.4611**	0.027
doutput3	-02737	0.258	doutput3	-0.2824	0.218
dwages	-0.0157	0.876	dwages_1	0.1231	0.234
dwages1	-0.1860*	0.085	dinterestr	0.0041*	0.099
dinterestr	0.0061**	0.032	dinterestr1	0.0051*	0.057
dinterestr1	0.0051*	0.067	dinterestr2	0.0046*	0.062
dinterestr2	0.0043	0.105	dinterestr3	0.0077***	0.002
dinterestr3	0.0075***	0.003	dinpt	-4.0756**	0.025
dinpt	-4.5273**	0.027	dtrend	-0.0106***	0.000
dtrend	-0.0103***	0.000	dfind0809	-0.025**	0.031
dfind0809	-0.0178	0.140	deea98	0.0021	0.875
deea98	0.0015	0.916	dbcea97	-0.0166	0.294
dbcea97	-0.0124	0.437	**ecm(-1)**	**-0.6342*** **	**0.000**
ecm(-1)	**-0.6272*** **	**0.000**			

Notes: ***,**,* indicate significance at 1% 5% and 10% respectively.

demployment=Lemployment$_t$−Lemployment$_{t-1}$.Other variables follow similar pattern.

Model 1: F-stat. F(18,39) 2.8616 [p-value 0.003]

Model 2: F-stat. F(17,40) 3.1719 [p-value 0.001]

Source: Author's own calculations using Microfit.

Table A.7: Diagnostic Tests for the ARDL Model

Model 1		Model 2	
Test statistics	F version		F version
Serial correlation	F(4,31)	1.6415 [p-value 0.189]	F(4,32) 1.5443 [p-value 0.213]
Functional Form	F(1,34)	0.1621 [p-value 0.690]	F(1,35) 0.0076[p-value 0.931]
Heteroscedasticity	F(1,56)	1.0879 [p-value 0.301]	F(1,56) 1.0667[p-value 0.306]
Adj R^2	0.91146		0.91482

Source: Author's own calculations using Microfit 4.1

Appendix B

Appendix to Chapter 3

Table B.1: Selected Developed and Emerging Market Currency Distribution of global exchange market (percentage shares of average daily turnover in April)-1998 to 2013

Currency	1998	2001	2004	2007	2010	2013
United States dollar	86.8(1)	89.9(1)	88.0(1)	85.6(1)	84.9(1)	87.0(1)
European euro	...(32)	37.9(2)	37.4(2)	37.0(2)	39.1(2)	33.4(2)
Japanese yen	21.7(2)	23.5(3)	20.8(3)	17.2(3)	19.0(3)	23.0(3)
British pound	11.0(3)	13.0(4)	16.5(4)	14.9(4)	12.9(4)	11.8(4)
Australian dollar	3.0(6)	4.3(7)	6.0(6)	6.6(6)	7.6(5)	8.6(5)
Canadian dollar	3.5(5)	4.5(6)	4.2(7)	4.3(7)	5.3(7)	4.6(7)
Mexican peso	0.5(9)	0.8(14)	1.1(12)	1.3(12)	1.3(14)	2.5(8)
Chinese renminbi	0.0(30)	0.0(35)	0.1(29)	0.5(20)	0.9(17)	2.2(9)
Russian rouble	0.3(12)	0.3(19)	0.6(17)	0.7(18)	0.9(16)	1.6(12)
Turkish lira	...(33)	0.0(30)	0.1(28)	0.2(26)	0.7(19)	1.3(16)
Korean won	0.2(18)	0.8(15)	1.1(11)	1.2(14)	1.5(11)	1.2(17)
South African rand	0.4(10)	0.9(13)	0.7(16)	0.9(15)	0.7(20)	1.1(18)
Brazilian real	0.2(16)	0.5(17)	0.3(21)	0.4(21)	0.7(21)	1.1(19)
Indian rupee	0.1(22)	0.2(21)	0.3(20)	0.7(19)	1.0(15)	1.0(20)
Polish zloty	0.1(26)	0.5(18)	0.4(19)	0.8(17)	0.8(18)	0.7(22)
Malaysian ringgit	0.0(27)	0.1(26)	0.1(30)	0.1(28)	0.3(25)	0.4(25)
Chilean peso	0.1(24)	0.2(23)	0.1(25)	0.1(30)	0.2(29)	0.3(28)

Note:the number outside the brackets represents the share of the currency while the number in brackets represents the rank of the currency.

Source: Bank for International Settlements, Triennial Central Bank Survey (2013).

Table B.2: Standard Deviations of Real domestic currency per US dollar, 1992-2013

Year	Brazil	India	SA	SK	Malaysia	Mexico	Russia	Turkey
1992	2.65[2.72]	0.15[0.15]	0.98[1]	0.07[0.07]	1.24[1.27]	0.34[0.35]	3.67[3.75]	1.56[1.60]
1993	2.30[2.92]	1.36[1.73]	0.79[1]	0.06[0.08]	1.64[2.08]	0.33[0.42]	1.81[2.29]	2.40[3.05]
1994	4.12[4.89]	0.16[0.19]	0.84[1]	0.06[0.07]	1.63[1.94]	1.55[1.84]	1.35[1.61]	37.86[45]
1995	3.32[7.37]	0.52[1.15]	0.45[1]	0.18[0.40]	1.14[2.54]	4.21[9.35]	1.06[2.35]	9.54[21.2]
1996	0.89[0.66]	0.60[0.44]	1.35[1]	0.15[0.11]	0.84[0.63]	0.72[0.54]	0.36[0.27]	6.97[5.18]
1997	0.68[0.70]	0.340.35]	0.98[1]	1.50[1.53]	4.23[4.34]	0.81[0.83]	0.17[0.18]	3.67[3.76]
1998	0.63[0.27]	0.47[0.20]	2.29[1]	1.06[0.46]	6.34[2.77]	1.26[0.55]	3.34[1.46]	3.27[1.43]
1999	12.54[21]	0.28[0.48]	0.59[1]	0.39[0.66]	0.37[0.63]	0.63[1.07]	0.47[0.80]	1.75[2.97]
2000	2.01[1.86]	0.21[0.19]	1.08[1]	0.36[0.33]	0.29[0.27]	0.73[0.67]	0.40[0.37]	1.87[1.73]
2001	3.78[2.10]	0.25[0.14]	1.80[1]	0.32[0.18]	0.32[0.18]	0.75[0.42]	0.13[0.07]	10.16[5.63]
2002	4.17[2.76]	0.21[0.14]	1.51[1]	0.28[0.18]	0.22[0.15]	0.54[0.36]	0.19[0.13]	6.67[4.42]
2003	3.18[3.01]	0.22[0.21]	1.06[1]	0.34[0.32]	0.33[0.31]	0.99[0.94]	0.29[0.28]	5.54[5.23]
2004	2.53[1.22]	0.31[0.15]	2.07[1]	0.31[0.15]	0.27[0.13]	0.70[0.34]	0.39[0.19]	6.16[2.98]
2005	2.71[1.72]	0.21[0.13]	1.57[1]	0.24[0.15]	0.51[0.32]	0.50[0.32]	0.27[0.17]	4.67[2.96]
2006	2.50[1.22]	0.36[0.17]	2.05[1]	0.23[0.11]	0.83[0.40]	0.83[0.40]	0.26[0.13]	9.62[4.69]
2007	3.00[2.31]	0.43[0.33]	1.30[1]	0.22[0.17]	0.98[0.75]	0.43[0.33]	0.29[0.22]	5.10[3.93]
2008	9.48[3.45]	0.65[0.24]	2.75[1]	1.01[0.37]	1.91[0.69]	1.88[0.68]	0.63[0.23]	20.72[7.54]
2009	3.29[2.11]	0.61[0.39]	1.56[1]	0.87[0.55]	1.60[1.03]	1.38[0.88]	1.58[1.02]	6.79[4.35]
2010	3.67[3.25]	0.51[0.45]	1.13[1]	0.51[0.45]	1.47[1.30]	0.85[0.75]	0.57[0.51]	9.37[8.28]
2011	7.23[4.48]	0.59[0.37]	1.61[1]	0.56[0.35]	2.46[1.52]	0.99[0.61]	0.92[0.57]	8.05[4.98]
2012	5.67[4.18]	0.73[0.54]	1.35[1]	0.29[0.21]	1.96[1.45]	1.12[0.83]	0.86[0.64]	5.91[4.36]
2013	5.29[4.35]	0.71[0.58]	1.22[1]	0.27[0.22]	1.76[1.44]	0.89[0.73]	0.49[0.40]	6.17[5.07]
Ave	3.89[3.58]	0.45[0.40]	1.38[1]	0.42[0.32]	1.47[1.19]	1.02[1.05]	0.89[0.80]	7.90[6.83]

Note: the number not in the bracket represents the standard deviation for that year calculated using the real exchange rate for the 12 months from 1993 to 2012. 1992 used only from July to December and 2013 used only from January till November. The number in the square bracket refers to how the volatility of another currency is relative to South Africa's rand. A value less than one implies that the currency in question has less volatility when compared to South Africa's rand. SA = South Africa. SK = South Korea.
Source: Author's own calculations.

Table B.3: Unit Root Tests using Augmented Dickey-Fuller method

Variable	ADF-statistic	ADF-statistic	Critical Values			
	levels	first difference	1%	5%	10%	Prob
LRERCPI	-2.429	-13.356	-2.572	-1.942	-1.616	0.0000***
LRERWPI	-2.564	-12.680	-2.572	-1.942	-1.616	0.0000***
LRUSNOM	-2.172	-12.950	-2.572	-1.942	-1.616	0.0000***
LREER	-3.329	-13.404	-2.572	-1.942	-1.616	0.0000***
LNEER	-2.942	-13.295	-2.572	-1.942	-1.616	0.0000***
LFXRES	-3.224	-5.414	-2.572	-1.942	-1.616	0.0000***
LM1	-1.450	-6.524	-2.572	-1.942	-1.616	0.0000***
LOUTPUT	-1.546	-2.911	-2.572	-1.942	-1.616	0.0036***
LTO	-3.053	-24.371	-2.572	-1.942	-1.616	0.0000***
LRGOLDP	-1.648	-15.421	-2.572	-1.942	-1.616	0.0000***

Notes: Variables are defined as in section 4. *** indicates significant at 1%. The values in levels include the constant and trend.

Source: Output using Eviews 8.

Table B.4: Unit Root Tests using Phillips-Perron method

Variable	PP-statistic	PP-statistic	Critical Values			
	levels	first difference	1%	5%	10%	Prob
LRERCPI	-2.189	-13.172	-2.572	-1.942	-1.616	0.0000***
LRERWPI	-3.064	-13.785	-2.572	-1.942	-1.616	0.0000***
LRUSNOM	-1.746	-12.898	-2.572	-1.942	-1.616	0.0000***
LREER	-3.000	-12.999	-2.572	-1.942	-1.616	0.0000***
LNEER	-2.340	-13.185	-2.572	-1.942	-1.616	0.0000***
LFXRES	-2.623	-18.391	-2.572	-1.942	-1.616	0.0000***
LM1	-1.070	-20.653	-2.572	-1.942	-1.616	0.0000***
LOUTPUT	-1.678	-6.152	-2.572	-1.942	-1.616	0.0000***
LTO	-7.624		-3.986	-3.423	-3.135	0.0000***
LRGOLDP	-1.816	-15.443	-2.572	-1.942	-1.616	0.0000***

Notes: Variables are defined as in section 4. *** indicates significant at 1%. The values in levels include a constant and trend.

Source: Output using Eviews 8.

Table B.5: Descriptive Statistics: 1986M2 — 2013M11

Variables	Obs	Mean	Std.Dev	Skewness	Kurtosis	Jarque-Bera
DRERCPI	334	-5.24E-05	0.0339	0.6254	8.4403	433.6542***
DRERWPI	334	-0.000262	0.0343	0.2981	6.6296	188.2813***
DRUSNOM	334	0.004391	0.0348	0.7678	8.2241	412.6215***
DREER	334	-0.000243	0.0263	-1.8816	15.266	2291.028***
DNEER	334	-0.005165	0.0300	-1.1637	10.6334	8886.2750***
DFXRES	334	0.018038	0.0707	2.3148	21.7178	5174.093***
DM1	334	0.011719	0.0278	0.5286	4.3713	41.7200***
DOUTPUT	334	0.002266	0.0091	-0.4648	2.4613	16.06644***
DTO	334	-0.000512	0.0886	-0.1780	2.9423	1.8094
DRGOLDP	334	0.006050	0.0428	0.7261	5.9301	148.8278***

Notes: *** indicates significant at 1%. Obs = number of observation. Std.Dev = standard deviation
Source: Output using Eviews 8.

Table B.6: Heteroskedasticity test

Variable	F-statistic	Prob. F	Obs*R-squared	Prob
DRERCPI	4.0457	0.0185**	7.9696	0.0186**(w)
DRERWPI	4.3226	0.0140**	8.5010	0.0143**(w)
DRUSNOM	4.3829	0.0132**	8.6167	0.0135**(w)
DREER	14.1441	0.0002***	13.6450	0.0002***(lm)
DNEER	6.3059	0.0021***	12.2579	0.0022***(w)
DFXRES	2.3356	0.0554*	9.2209	0.0558*(lm)
DM1	9.4531	0.0023***	9.2455	0.0024***(lm)
DOUTPUT	27.2892	0.0000***	25.3576	0.0000***(lm)
DRGOLDP	3.6182	0.0279**	7.1450	0.0281***(lm)

Notes:***,**,* indicates significant at 1%,5% and 10% respectively. (w) indicates that the white test is used and (lm) indicates that the ARCH-LM test is used.
Source: Output using Eviews 8.

Table B.7: Correlation matrix for all the variables

	rercpi	rerwpi	rusnom	reer	neer	fxres	m1	output	rgoldp	Dto
rercpi	1.000									
rerwpi	0.913	1.000								
rusnom	0.980	0.920	1.000							
reer	0.873	0.764	0.866	1.000						
neer	0.928	0.865	0.909	0.938	1.000					
fxres	-0.015	-0.071	-0.042	0.018	0.013	1.000				
m1	0.073	0.170	0.054	0.076	0.052	0.021	1.000			
output	0.028	-0.042	0.012	0.040	0.024	-0.006	-0.241	1.000		
rgoldp	0.664	0.630	0.694	0.649	0.655	-0.056	-0.071	0.088	1.000	
Dto	-0.072	-0.064	-0.070	-0.008	-0.023	-0.010	-0.032	-0.018	-0.024	1.000

Notes: all the variables except trade openness (Dto) are defined as volatility.

Source: Output using Eviews 8.

Figure B.1: Estimated Conditional Variance for RERCPI

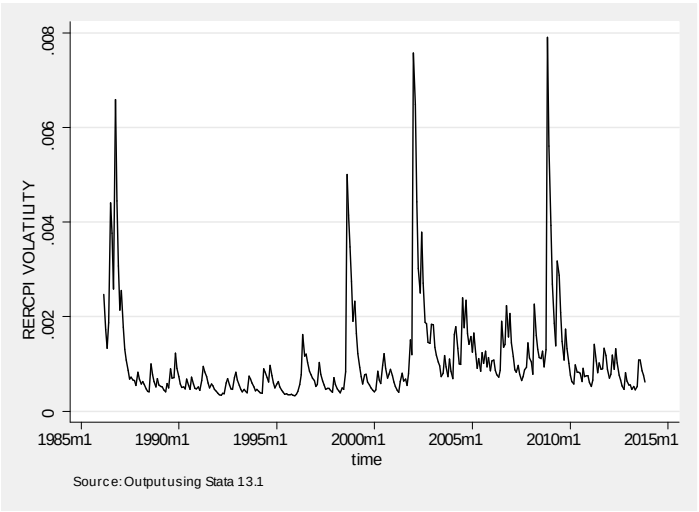


Figure B.2: Estimated Conditional Variance for RERWPI

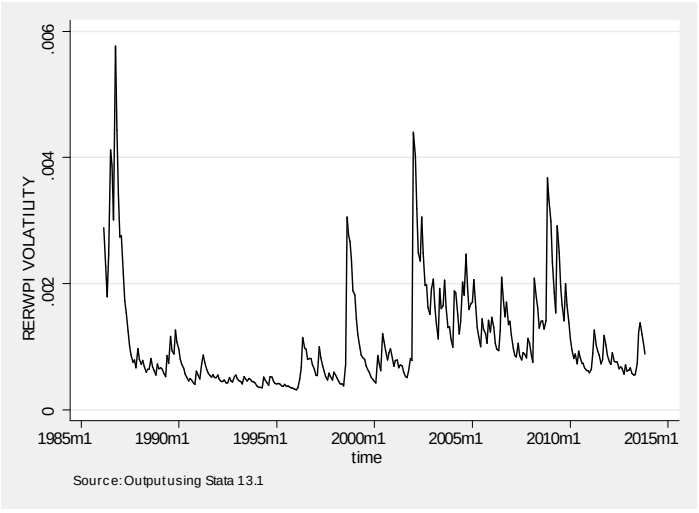


Figure B.3: Estimated Conditional Variance for RUSNOM

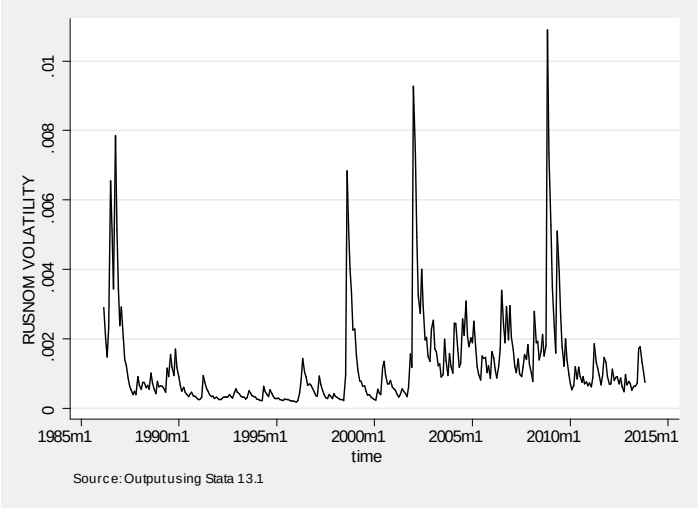


Figure B.4: Estimated Conditional Variance for REER

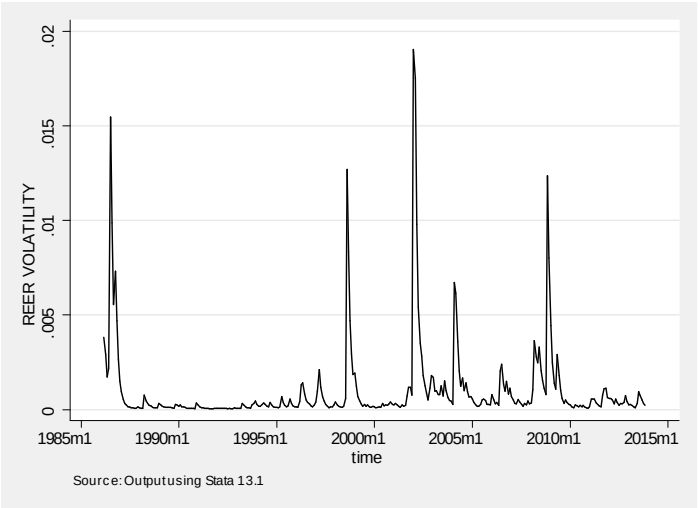


Figure B.5: Estimated Conditional Variance for NEER

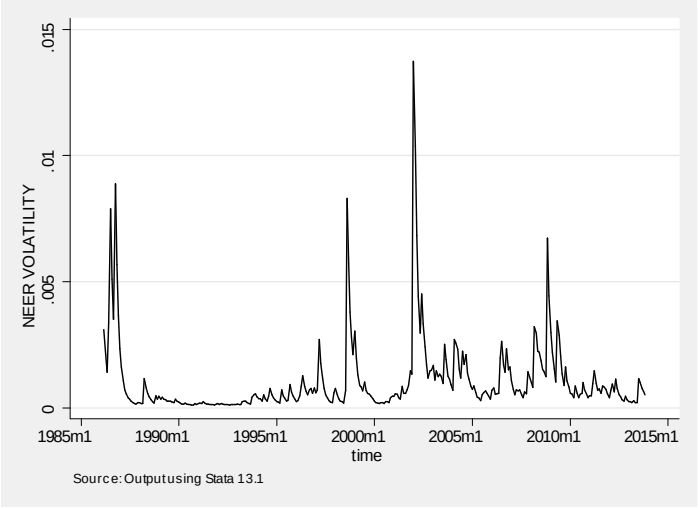


Table B.8: GARCH(1,1) results

Parameters	RERCPI	RERWPI	RUSNOM	REER	NEER
Mean eq.					
constant	-0.0031	-0.0031*	0.0034**	0.0002	-0.0056***
OUTPUT	-0.0221	0.2601**	0.1507	-0.1238	0.0972
MS1	-0.0243	0.0268	0.0393	0.00644	0.0098
TO	-0.0143	0.0057	0.0050	-0.0058	0.0093
FXRES	0.0352	0.0229	0.0296**	-0.0352***	-0.0274**
RGOLDP	0.4236***	0.4102***	0.3828***	-0.2848***	-0.3683***
DUM95	0.0011	0.0012	-0.0026	0.0018	0.0056***
AR(1)	0.2969***	0.2763***	0.3260***	0.4518***	0.2369***
AR(2)	-0.1018**	-0.1402***	-0.0874**	-0.1456**	-0.1144***
AR(3)				-0.0546	0.0584
AR(4)					0.0120
Variance eq.					
constant	0.000425***	1.82E-05***	5.69E-06***	9.35E-05***	0.000138***
ε_{t-1}^2	0.051049	-0.008295	0.042193*	0.151845**	-0.034893
h_{t-1}^2	0.456813***	0.945597***	0.897797***	0.418091***	0.629204***
OUTPUT	0.003226	0.003028**	0.002112	-0.005413***	-0.001911
MS1	-0.005038***	-0.000583	0.000151	-0.000181	-0.001079
TO	0.000839	-0.001149***	-0.001027***	0.000388*	-9.12E-05
FXRES	-0.000196	-2.57E-05	7.87E-05	4.62E-05	-0.000392***
RGOLDP	0.002519	0.001221**	0.001453*	0.001101***	0.002243***
DUM95	-5.58E-05	1.64E-05***	1.95E-05**	4.58E-05**	7.57E-05
$\varepsilon_{t-1}^2 + h_{t-1}^2$	0.5078	0.9373	0.9401	0.5699	0.5943

Notes:***,**,* indicates significant at 1%,5% and 10% respectively. eq stands for equation. The variables are defined in section four. The p-values are based on Bollerslev-Wooldridge robust standard errors and covariance. Source: Output using Eviews 8.

Table B.9: EGARCH(1,1) results

Parameters	RERCPI	RERWPI	RUSNOM	REER	NEER
Mean eq.					
constant	-0.0012	-0.0036**	0.0028*	5.41E-05	-0.0048***
OUTPUT	0.0990	0.2899**	0.2521**	-0.1589**	0.1201*
MS1	-0.0059	0.0565	0.0308	-0.0012	-0.0175
TO	-0.0076	0.0081	-0.0041	0.0048	0.0238***
FXRES	0.0275*	0.0321***	0.0240*	-0.0174***	-0.0134*
RGOLDP	0.3721***	0.390450***	0.3702***	-0.2194***	-0.3588***
DUM95	-0.0015	0.000129	-0.0029	0.0023	0.0058***
AR(1)	0.3293***	0.311881***	0.3664***	0.4983***	0.3068***
AR(2)	-0.1092**	-0.155444***	-0.1072**	-0.1506***	-0.1592***
AR(3)		0.110265***		-0.0502	
AR(4)		-0.106173**		0.1089***	
AR(5)		-0.006562		-0.1083***	
AR(6)		-0.085971**		0.0542*	
Variance eq.					
constant	-0.327496***	-0.241081***	-0.163864***	-2.052698**	-0.898405***
$\alpha_1\{\varepsilon_{t-1}/(h_{t-1})^{0.5}\}$	-0.153281**	-0.082110	-0.086716	0.151501	-0.349279***
$\lambda_1\{\varepsilon_{t-1}/(h_{t-1})^{0.5}\}$	0.015563	0.049909	0.041082	-0.127942*	-0.008927
$\ln(h_{t-1})$	0.945410***	0.966386***	0.978000***	0.792796***	0.866341***
OUTPUT	10.02419**	4.311940	7.945157**	-17.36371***	1.786508
MS1	-1.453856	0.135521	1.161004	1.6748	1.814034
TO	-0.448686	-0.979166	-0.390136	0.1495	-0.632399*
FXRES	0.490851	-0.187143	0.087639	-0.387790	-1.355489***
RGOLDP	1.693462**	-0.078400	0.666949	7.983027***	5.110445***
DUM95	0.018627	0.059399***	0.040779***	0.191110	0.108753***

Notes:***,**,* indicates significant at 1%,5% and 10% respectively. eq stands for equation. The variables are defined in section four.

Source: Output using Eviews 8.

Table B.10: Diagnostic tests

	RERCPI	RERWPI	RUSNOM	REER	NEER
GARCH(1,1)					
Q-test: v_t					
Q(2)	2.0625(0.357)	2.0334(0.362)	1.2700(0.530)	0.3042(0.859)	1.3215(0.516)
Q(4)	4.4159(0.353)	6.0916(0.192)	1.7851(0.775)	2.3602(0.670)	1.4559(0.834)
Q(6)	4.4917(0.610)	7.0069(0.320)	1.8693(0.931)	5.9833(0.425)	5.9960(0.424)
Q-test: v_t^2					
Q(2)	0.5023(0.778)	1.2471(0.536)	0.0247(0.988)	3.5327(0.171)	0.6145(0.735)
Q(4)	5.1905(0.268)	1.5755(0.813)	0.5093(0.973)	3.6964(0.449)	0.6742(0.954)
Q(6)	6.3759(0.382)	5.5920(0.470)	4.2332(0.645)	4.6683(0.587)	3.7986(0.704)
ARCH-LM	0.2295(0.6317)	0.0003(0.9861)	0.0004(0.9832)	2.5127(0.1129)	0.0068(0.9343)
Log likelihood	754.1531	774.8246	774.8326	920.2729	822.4597
AIC	-4.4347	-4.5592	-4.5592	-5.4458	-4.8634
SIC	-4.2284	-4.3529	-4.3529	-5.2275	-4.6331
EGARCH(1,1)					
Q-test: v_t					
Q(2)	0.9681(0.616)	1.0351(0.596)	0.8492(0.654)	0.3002(0.861)	1.9718(0.373)
Q(4)	3.2902(0.510)	1.3807(0.848)	2.8105(0.590)	0.9172(0.922)	4.8371(0.304)
Q(6)	3.7941(0.705)	7.6779(0.263)	3.1076(0.795)	3.3576(0.763)	7.3571(0.289)
Q-test: v_t^2					
Q(2)	2.0938(0.351)	1.0351(0.596)	0.0900(0.956)	3.9200(0.141)	1.9697(0.373)
Q(4)	5.0341(0.284)	1.3807(0.848)	0.8412(0.933)	5.9449(0.203)	2.7384(0.603)
Q(6)	9.4561(0.150)	7.6779(0.263)	4.6388(0.591)	8.9929(0.174)	6.3968(0.380)
ARCH-LM	0.2136(0.6440)	0.1870(0.6654)	0.0006(0.9798)	2.0755(0.1497)	1.2537(0.2628)
Log likehood	777.5297	777.5982	786.9701	944.3293	847.5239
AIC	-4.5695	-4.6012	-4.6263	-5.6179	-4.9911
SIC	-4.3517	-4.3352	-4.4086	-5.3519	-4.7733

Notes: Q-test: v_t and Q-test: v_t^2 are tests for the presence of serial correlation and remaining ARCH/GARCH effects conducted on Ljung-Box Q-statistic of standardised and squared standardised residuals respectively. The number in brackets is the p-value. The optimal lag length(k) of 6 for the Q-test statistic is chosen according to the suggestion by Tsay (2002) that k=$\ln(T)$ where T is the number of observations. AIC is Akaike info criterion and SIC is Schwarz criterion.

Source: Output using Eviews 8.

Table B.11: Pairwise Granger Causality Tests for Rand volatility and Gold price volatility

Null Hypothesis	lags	obs	F-statistic	P-value
NEERvola $\Longrightarrow$Goldpvola	1	332	0.60854	0.4359
Goldpvola$\Longrightarrow$NEERvola	1	332	3.15102	0.0768*
REERvola$\Longrightarrow$Goldpvola	1	332	0.37146	0.5426
Goldpvola$\Longrightarrow$REERvola	1	332	4.14174	0.0426**
RERCPIvola$\Longrightarrow$Goldpvola	1	332	0.71132	0.3996
Goldpvola$\Longrightarrow$RERCPIvola	1	332	5.41292	0.0206**
RERWPIvola$\Longrightarrow$Goldpvola	1	332	0.39736	0.5289
Goldpvola$\Longrightarrow$RERWPIvola	1	332	5.67514	0.0178**
RUSNOMvola$\Longrightarrow$Goldpvola	1	332	1.54394	0.2149
Goldpvola$\Longrightarrow$RUSNOMvola	1	332	5.97100	0.0151**

Notes:$\Longrightarrow$ stands for "does not Granger Cause". NEER =nominal effective exchange rate vola=volatility. Goldp=gold price.REER=real effective exchange rate. RERCPI=real bilateral exchange rate using consumer price indices.RERWPI= real bilateral exchange rate using wholesale price index and CPI.RUSNOM=nominal bilateral exchange rate. obs=observations.

Source: Output using Eviews 8.

B.0.1 The Model

This model considers a small open economy with the nontraded goods sector characterised with monopoly and sticky-price problems while the traded sector has a single homogeneous output which is priced competitively in the world markets. Each representative home agent is endowed with a constant quantity of the traded good each period ,$\bar{y}_T$, and has a monopoly power over one of the nontradables $z \in [0,1]$. The model assumes that all agents have identical preferences characterised by an intertemporal utility function that depends positively on consumption and real money balances but negatively on work effort. With this, the intertemporal utility function of the home agent j is given by

$$U_t^j = \sum_{S=t}^{\infty} \beta^{S-t} \left[\gamma \ln C_{T,S}^j + (1-\gamma) \ln C_{N,S}^j + \frac{\chi}{1-\varepsilon} \left(\frac{M_S^j}{P_S} \right)^{1-\varepsilon} - \frac{\kappa}{2} y_{N,S}(j)^2 \right] \tag{B.1}$$

where C_T is the consumption of the traded good and C_N is the consumption of the composite nontraded goods, defined :

$$C_N = \left[\int_0^1 c_N(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}} \tag{B.2}$$

Consumption based price index, P, is defined as the minimum money cost of purchasing one

unit of composite real consumption $C_T^{\gamma} C_N^{1-\gamma}$. This price index is represented as:

$$P = \frac{P_T^{\gamma} P_N^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}} \tag{B.3}$$

where P_T is the price of tradables, P_N is the nontraded goods price index, defined as

$$P_N = \left[\int_0^1 p_N(z)^{1-\theta} dz \right]^{\frac{1}{1-\theta}} \tag{B.4}$$

where $p_N(z)$ is the money price of nontraded good z. Domestic prices P_T are linked to the world prices P_T^* (assumed to be constant) through the exchange rate, E. This is represented as follows:

$$P_T = E P_T^* \tag{B.5}$$

In addition, the model assumes the existence of an international bond market with real bonds denominated in tradables. The constant world net interest rate in tradables is denoted by r and $\beta(1+r) = 1$. The intertemporal budget constraint for the representative home agent j is denoted by

$$\begin{aligned} P_{T,t} B_{t+1}^j + M_t^j &= P_{T,t}(1+r) B_t^j + M_{t-1}^j + p_{N,t}(j) y_{N,t}(j) + P_{T,t} \bar{y_T} - \\ &\quad P_{N,t} C_{N,t}^j - P_{T,t} C_{T,t}^j - P_{T,t} \tau_t \end{aligned} \tag{B.6}$$

where τ_t is per capita taxes denominated in tradables and B_t is the bond portfolio. The model assumes that the government balances its budget in units of tradables and its constraint is as follows:

$$\tau_t + \frac{M_t - M_{t-1}}{P_{T,t}} = 0 \tag{B.7}$$

Finally the preferences take the Constant Elasticity of Substitution (CES) form. This makes the producers of non-traded goods to face the following demand curve:

$$y_N^d(j) = \left[\frac{p_N(j)}{P_N} \right]^{-\theta} C_N^A \tag{B.8}$$

where C_N^A is the aggregate per capita consumption of nontraded goods.

Solving the agent's optimisation problem requires maximising equation B.1 subject to equations B.6 and B.8 with respect to the choice variables $B_{t+1}^j, M_t, C_{N,t}$ and $y_{N,t}$. This results

in the following four first-order conditions(FOC):

$$C_{T,t+1} = C_{T,t} \tag{B.9}$$

$$\frac{\gamma}{C_{T,t}} = \chi \frac{P_{T,t}}{P_t} \left(\frac{M_t}{P_t} \right)^{-\varepsilon} + \beta \frac{P_{T,t}}{P_{T,t+1}} \left(\frac{\gamma}{C_{T,t+1}} \right) \tag{B.10}$$

$$C_{N,t} = \frac{1-\gamma}{\gamma} \left(\frac{P_{T,t}}{P_{N,t}} \right) C_{T,t} \tag{B.11}$$

$$y_{N,t}^{\frac{\theta+1}{\theta}} = \left[\frac{(\theta-1)(1-\gamma)}{\kappa\theta} \right] \left(C_{N,t}^{A} \right)^{\frac{1}{\theta}} \frac{1}{C_{N,t}} \tag{B.12}$$

Equation B.9 shows the Euler condition for optimal intertemporal consumption smoothing for traded goods. Equation B.10 shows the utility maximising trade-off between consumption spending in period t and a combination of one-period money holding and consumption spending in period $t+1$. Equation B.11 states that the marginal utility of traded and nontraded consumption must be equal at any given time. Equation B.12 depicts the condition for optimal monopolistic price setting. Hau (2002) states that the left hand sides depicts the marginal consumption utility of an additional unit of nontraded good while the right hand side depicts the marginal disutility of production of an additional unit. As a result, a mark up of $\theta/\theta - 1$ is added by monopolistically competitive firms.

Substituting equation B.9 into equation B.10 leads to the following expression for money demand:

$$\frac{M_t}{P_t} = \{ \frac{\frac{\chi}{\gamma} C_{T,t} \frac{P_{T,t}}{P_t}}{\left(1 - \beta \frac{P_{T,t}}{P_{T,t+1}} \right)} \}^{\frac{1}{\varepsilon}} \tag{B.13}$$

implying the demand for real balances depends on consumption of tradables, $C_{T,t}$, changes in the price of tradables, $P_{T,t}$ / $P_{T,t+1}$ and changes in the real price of tradables, $P_{T,t}$ / P_t.

Including government spending, the model assumes that government spending, G, is dissipative and does not affect productivity or private utility. It also assumes that government's real consumption index takes the same general form as the private sector's. With government spending, equation B.7 becomes:

$$G_t = \tau_t + \frac{M_t - M_{t-1}}{P_t} \tag{B.14}$$

Given that preferences take the CES form, the producers of non-traded goods take the form:

$$y_{N,t}^{d} = \left[\frac{p_{N,t}(j)}{P_{N,t}}\right]^{-\theta} \left(C_{N}^{A} + G_{N}^{A}\right) \tag{B.15}$$

where C_{N}^{A} is home country's private demand for non-traded goods and G_{N}^{A} is home country's public demand for non-traded goods. Implying solving the optimisation problem including the government spending leads to equation B.12 only, changing to

$$y_{N,t}^{\frac{\theta+1}{\theta}} = \left[\frac{(\theta+1)(1-\gamma)}{\kappa\theta}\right] \left(C_{N,t}^{A} + G_{N,t}^{A}\right)^{\frac{1}{\theta}} \frac{1}{C_{N,t}} \tag{B.16}$$

Appendix C

Appendix to Chapter 4

Table C.1: Rank Ordered Volatility of Selected Major Emerging Market Currencies- 1 March 2000 to 31 December 2014

Currency	A	Currency	B	Currency	C
South African rand	9.3%	South Africa rand	10.5%	Hungarian forint	8.7%
Hungarian forint	8.2%	Turkish lira	9.6%	Polish zloty	8.1%
Brazilian real	8.1%	Brazilian real	9.2%	South Africa rand	8.1%
Turkish lira	7.7%	Hungarian forint	7.7%	Brazilian real	7.0%
Polish zloty	7.5%	Czech koruna	7.0%	Swedish krona	7.0%
Swedish krona	6.9%	Polish zloty	6.9%	Czech koruna	6.7%
Czech koruna	6.9%	Norwegian krone	6.9%	Norwegian krone	6.7%
Norwegian krone	6.8%	Swedish krona	6.9%	Russian rouble	5.9%
Danish krone	5.6%	Danish krone	6.2%	Turkish lira	5.8%
Chilean peso	5.6%	Chilean peso	6.0%	Mexican peso	5.7%
Mexican peso	5.3%	Mexican peso	5.0%	Korean won	5.4%
Korean won	4.8%	Korean won	4.3%	Chilean peso	5.2%
Russian rouble	3.9%	Thai baht	3.3%	Danish krone	5.0%
Indian rupee	3.0%	Singapore dollar	2.8%	Indian rupee	3.9%
Singapore dollar	2.8%	Taiwan dollar	2.2%	Malaysian ringgit	3.2%
Thai baht	2.7%	Indian rupee	2.0%	Singapore dollar	2.8%
Malaysian ringgit	2.1%	Russian rouble	1.9%	Thai baht	2.1%
Taiwan dollar	2.0%	Malaysian ringgit	1.0%	Taiwan dollar	1.7%
Chinese yuan	0.5%	Chinese yuan	0.4%	Chinese yuan	0.6%
Hong Kong dollar	0.2%	Hong Kong dollar	0.2%	Hong Kong dollar	0.2%
Median	5.0%	Median	5.5%	Median	5.55%
Mean	5.45%	Mean	5.0%	Mean	5.0%

Notes: A is entire sample period. B is 1 March 2000 - 15 September 2008 and C is 16 September 2008 to 31 December 2014. Exchange rates are domestic nominal exchange rate per US dollar. Volatility is measured as the absolute percentage changes. These currencies are chosen based on liquid exchange rates classification by the Bank of International Settlements Triennial Central Bank Survey 2013.
Source: Author's own calculations based on the data from Datastream.

Table C.2: South African monetary policy actions, 2000 — 2014

Date	Repo rate	Δ in policy rate	Date	Repo rate	Δ in policy rate
6April2000		No	16Aug2007	10%	Yes.↑by 50bps
19May2000		No	11Oct2007	10.5%	Yes.↑by 50bps
15June2000		No	10April2008	11.5%	Yes.↑by 50bps
11Aug2000		No	12June2008	12%	Yes.↑by 50bps.
21Sept2000		No	14Aug2008		No
19Jan2001		No	11Dec2008	11.5%	Yes.↓by 50bps
16Mar2001		No	22Oct2009		No
14June2001	11%	Yes↓by 100bps	26Jan2010		No
15Nov2001		No	13May2010		No
13Jun2002	12.5%	Yes.↑by 100bps	22Jul2010		No
28Nov2002		No	9Sept2010	6%	Yes.↓by 50bps
20Mar2003		No	18Nov2010	5.5%	Yes.↓by 50bps
12Jun2003	12%	Yes.↓by 150bps	20Jan2011		No
14Aug2003	11%	Yes. ↓by 100bps	24Mar2011		No
10Sept2003	10%	Yes.↓by 100bps	21Jul2011		No
16Oct2003	8.5%	Yes.↓by 150bps	19Jan2012		No
11Dec2003	8%	Yes.↓by 50bps	24May2012		No
10Jun2004		No	19Jul2012	5%	Yes.↓by 50bps
12Aug2004	7.5%	Yes.↓50bps	20Sept2012		No
14Oct2004		No	22Nov2012		No
11Aug2005		No	24Jan2013		No
13Oct2005		No	18Jul2013		No
8Dec2005		No	21Nov2013		No
13Apr2006		No	22May2014		No
8Jun2006	7.5%	Yes.↑by 50bps	17Jul2014	5.75%	Yes.↑by 25bps
12Oct2006	8.5%	Yes.↑by 50bps	20Nov2014		No
15Feb2007		No			
12April2007		No			

Notes:Δ refers to change. ↓ and ↑ refers to a reduction and increase respectively. bps refers to basis points
Source: Author's own compilation using SARB's monetary policy statements.

Table C.3: Impact of political events on South African rand

		CAR on Day 0		
Event date	Event Name	R/US$	Rand/British pound	Rand/Euro
16 Aug 2012	Marikana	0.0303**(2.5527)^a	0.0310***(3.6555)^a	0.0305***(2.8075)^a
		0.0303**(2.5586)^b	0.0310***(3.6717)^b	0.0306***(2.8190)^b
6 Nov 2012	Nelson Mandela banknotes released	-0.0110*(-1.8996)^a	-0.0148**(-1.9696)^a	-0.0170***(-2.9502)^a
		-0.0110*(-1.8994)^b	-0.0148**(-1.9681)^b	-0.0170***(-2.9404)^b
18 Dec 2002	ANC elective conference	0.0237(0.6031)^a	0.0389(0.6929)^a	0.0273(0.5667)^a
		0.0237(0.6050)^b	0.0309(0.6946)^b	0.0274(0.5692)^b
18 Dec 2007	ANC elective conference	0.0327*(1.7510)^a	0.0102(0.6172)^a	0.0219(1.4211)^a
		0.0327*(1.7514)^b	0.0102(0.6157)^b	0.0219(1.4218)^b
18 Dec 2012	ANC elective conference	-0.0199*(-1.8143)^a	-0.0090(-1.5962)^a	-0.0098(-1.1805)^a
		-0.0198*(-1.8122)^b	-0.0090(-1.5954)^b	-0.0099(-1.1870)^b

Notes:The number in brackets represents the t-test.***,**,* represents significance at 1%,5% and 10% respectively.

^{a} is when the estimated model uses lagged forward rates.^{b} is when the estimated model uses lagged spot rates.

The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% respectively.

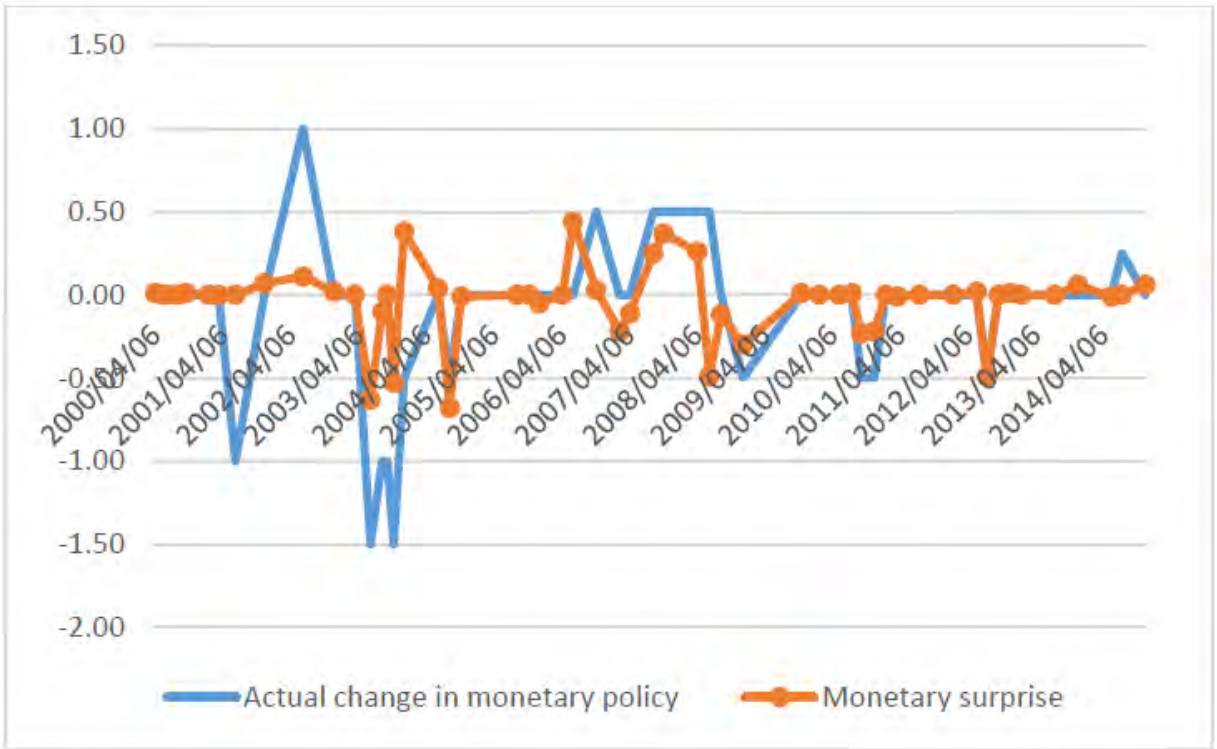
Source: Output using Stata 13.

Table C.4: Impact of monetary policy announcements on Rand/US Dollar

		(1)	(2)
Event Date	Announcement	CAR on Day 0	CAR on Day 0
14June2001	MPC↓ 100*bps*	-0.0106362(-1.983202)**	-0.010678(-1.991302)**
13June 2002	MPC↑ 100*bps*	0.0491712(4.556471)***	0.0491367(4.551802)***
12June2003	MPC↓ 150*bps*	-0.0115378(-0.7684953)	-0.0114954(-0.7643392)
16Oct2003	MPC↓ 150*bps*	0.0361704(1.421165)	0.0361842(1.421531)
8June2006	MPC no change	0.0032503(0.2371485)	0.0032387(0.2361848)
12Oct2006	MPC↑ 50*bps*	-0.0486286(-10.11522)***	-0.0486617(-10.11485)***
12April2007	MPC no change	0.0078953(1.251125)	0.0078878(1.251696)
16Aug2007	MPC↑ 50*bps*	0.000137(0.0052588)	0.0001506(0.005785)
10April2008	MPC↑ 50*bps*	-0.0053624(-0.9038789)	-0.0053625(-0.9038298)
11Dec2008	MPC↓ 50*bps*	-0.0036875(-0.1250792)	-0.0037004(-0.1255678)
18Nov2010	MPC↓ 50*bps*	-0.0065374(-3.082248)***	-0.0065286(-3.065214)***
17July2014	MPC↑ 25*bps*	-0.0048699(-1.430586)	-0.00487(-1.428312)

Notes: The number in brackets represents the t-test. ***, **, * represents significance at 1%, 5% and 10% respectively. (1) is when the estimated model uses lagged forward rates. (2) is when the estimated model uses lagged spot rates. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% respectively.
Source: Output using Stata 13.

Figure C.1: Actual change vs surprise monetary policy



Source: Author's own compilation using SARB's monetary policy statements

Table C.5: Impact of monetary policy announcements on Rand/British Pound

		(1)	(2)
Event Date	Announcement	CAR on Day 0	CAR on Day 0
14June2001	MPC↓ 100*bps*	0.0069115(1.276404)	0.0068982(1.273461)
13June 2002	MPC↑ 100*bps*	0.0529501(4.7876)***	0.05299(4.791819)***
12June2003	MPC↓ 150*bps*	0.0026227(0.1460384)	0.0026936(1.1497745)
16Oct2003	MPC↓ 150*bps*	0.0393204(2.560978)**	0.0393529(2.560238)**
8June2006	MPC no change	-0.0218886(-1.730924)*	-0.0218825(-1.730443)*
12Oct2006	MPC↑ 50*bps*	-0.0442963(-7.502626)***	-0.0443238(-7.508083)***
12April2007	MPC no change	0.0132191(3.040339)***	0.013203(3.034284)***
16Aug2007	MPC↑ 50*bps*	0.0106745(0.5610543)	0.0107488(0.5656992)
10April2008	MPC↑ 50*bps*	0.0064161(0.8745211)	0.0064147(0.8746411)
11Dec2008	MPC↓ 50*bps*	0.0105355(0.5614495)	0.0105397(0.5612687)
18Nov2010	MPC↓ 50*bps*	-0.0035825(-0.5928535)	-0.0035802(-0.5905555)
17July2014	MPC↑ 25*bps*	-0.0099839(-5.008295)***	-0.0099941(-5.018403)***

Notes: The number in brackets represents the t-test. ***, **, * represents significance at 1%, 5% and 10% respectively. (1) is when the estimated model uses lagged forward rates. (2) is when the estimated model uses lagged spot rates. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% respectively.
Source: Output using Stata 13.

Table C.6: Impact of monetary policy announcements on Rand/Euro

		(1)	(2)
Event Date	Announcement	CAR on Day 0	CAR on Day 0
14June2001	MPC↓ 100*bps*	0.0094775(1.498837)	0.0094796(1.495527)
13June 2002	MPC↑ 100*bps*	0.0506441(4.360235)***	0.0506938(4.366209)***
12June2003	MPC↓ 150*bps*	0.0011348(0.0585903)	0.0011675(0.0601805)
16Oct2003	MPC↓ 150*bps*	0.0385713(2.832234)***	0.0385666(2.834773)***
8June2006	MPC no change	-0.0190082(-1.806188)*	-0.0190022(-1.803291)*
12Oct2006	MPC↑ 50*bps*	-0.0432724(-7.513308)***	-0.0433205(-7.522163)***
12April2007	MPC no change	0.013249(2.881759)***	0.0132227(2.873255)***
16Aug2007	MPC↑ 50*bps*	0.0112908(0.6328499)	0.0113379(0.6361377)
10April2008	MPC↑ 50*bps*	0.0045373(0.7648868)	0.0045428(0.7656981)
11Dec2008	MPC↓ 50*bps*	0.0154837(0.4988458)	0.0155015(0.4993289)
18Nov2010	MPC↓ 50*bps*	-0.0056438(-0.6855884)	-0.0056379(-0.6891407)
17July2014	MPC↑ 25*bps*	-0.0083022(-3.77398)***	-0.0082946(-3.770786)***

Notes: The number in brackets represents the t-test. ***, **, * represents significance at 1%, 5% and 10% respectively. (1) is when the estimated model uses lagged forward rates. (2) is when the estimated model uses lagged spot rates. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% respectively.
Source: Output using Stata 13.